# DOCUMENT 1
# PROGRAM ANALYSIS

# SOUTH STATION INTERMODAL TRANSPORTATION CENTER

SOUTH STATION TRANSPORTATION CENTER

PROGRAM ANALYSIS

prepared for the
Boston Redevelopment Authority

by
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# CHAPTER 1 - PROJECT DESCRIPTION

## Background

The South Station railroad terminal, including the track area to the south, is owned by the Boston Redevelopment Authority (BRA). It is presently used by Amtrak inter-city trains and Penn Central commuter trains. The station is part of the South Station Urban Renewal Area. The renewal plan approved for this area in 1969 by the Boston City Council calls for construction of a major transportation center, parking facilities, and office and commercial space.

Renewal of the South Station area has been under study for more than 10 years, and many alternative schemes have been proposed. These have varied in scope and program, but all have proposed the consolidation of the existing rail operations, presently dispersed bus operations, and a large parking facility into a single Transportation Center. The building programs for these proposals have varied in accordance with the extent of transportation improvements and commercial development contemplated.

The BRA recently conducted a study to determine the probable environmental impacts of the urban renewal project.[1] A preliminary building scheme for a new Transportation Center, prepared by The Architects Collaborative, was used as a basis for evaluation of environmental impacts. The conceptual plan is now being modified as part of the design process, but the various transportation elements remain essentially consistent with those described in the environmental report. Some adjustments are being made in the number of parking spaces and in the number, operation, and location of bus bays and train tracks.

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1. Metcalf and Eddy, Inc., (Preliminary) Environmental Impact Report, South Station Urban Renewal Project, prepared for The Boston Redevelopment Authority, May 16, 1975.

The prime purpose of the present study is to present in one document all of the program elements for the Transportation Center. Some of these elements are based on space needs supplied by transportation operators who would be using the Center. Other elements are based on patronage forecasts, which have been prepared using available data on current ridership and estimates of population and employment growth. The process of preparing these patronage forecasts is detailed in a series of Technical Memoranda prepared by Parsons, Brinckerhoff, Quade & Douglas, Inc.[2] From these forecasts,movements between the different modes during the peak periods have been estimated. These estimates are important in determining the number and location of vertical movement elements within the Center, the design of horizontal movement spaces,and the provision of facilities for access to and from the Center by various modes.

## Transportation Center Objectives

The Transportation Center concept of accommodating several modes of travel at one location improves interchange among the modes and allows more efficient sharing of common facilities. Presently South Station is used only as a train terminal serving about 3,800 dailytrain commuters and approximately 700 daily intercity passengers in each direction. The location of South Station--on one edge of downtown, near the intersection of two major regional highways, and adjacent to a rapid transit station--is a logical place to provide a Transportation Center.

Major components planned for the Transportation Center will serve intercity rail, commuter rail, intercity buses, commuter buses, and auto parking. The intercity rail facility will be the northern terminal for Amtrak's Northeast Corridor service and will be sponsored in part by the Federal Railroad Administration. Commuter rail service, provided by the Penn Central Railroad for the Massachusetts Bay Transportation Authority from the southern and western suburbs, will also continue to originate and terminate at the South Station Transportation Center. Intercity bus facilities--which generally include passenger services and long-haul bus accommodations--will replace the current Greyhound and Trailways terminals in the Park Square area. Commuter buses operated by the MBTA and several private companies between the southern or western suburbs and downtown Boston will stop at the Transportation Center. A major parking garage

2. Parsons, Brinckerhoff, Quade & Douglas, Inc., for the Boston Redevelopment Authority--"Technical Memorandum #1, Future Intercity Rail Patronage," January 30,1976; "Technical Memorandum #2, Future Intercity and Commuter Bus Patronage," February 2,1976; "Technical Memorandum #3, Future Commuter Rail Patronage," February 4, 1976; "Technical Memorandum #4, Transportation Center Parking," March 1, 1976. These technical memoranda are included in the Appendix.

will be included to serve intercity bus and rail passengers, commuters, and visitors to downtown Boston.

The downtown location and the proximity of the subway will make the Transportation Center convenient for rail and bus commuters. The Transportation Center can be directly connected to the nearby Central Artery (Route I-93) and Turnpike (Route I-90) freeing buses from the congestion of city streets and providing convenient access for automobiles to pick up and drop off travelers. Similarly, replacement of current downtown parking with a facility having direct access to regional expressways will further reduce congestion on Boston's streets.

A Transportation Center must be more than a collection of different transportation terminals under one roof. It must relate these terminals in a functional way, provide interchange among them for passengers and baggage, and connect them conveniently with local transportation and with the city. Shops, services, and restaurants are also necessary, in order to provide a varied and exciting atmosphere for travelers and visitors alike.

The effect should be much like the large European railroad stations, which are usually more than just railroad stations. They are located at the point where local transit lines converge, provide airport and bus connections, and they serve visitors as an orientation center and local residents as a central meeting place.

# CHAPTER 2 - EXISTING CONDITIONS

The prime advantage in locating the Transportation Center at South Station is its accessibility, both from the central business district and from the rest of the Boston region. The site is served by the Massachusetts Bay Transportation Authority (MBTA) rapid transit system, and it is adjacent to the interchange between two major regional expressways, the Massachusetts Turnpike (I-90) and the Central Artery-Southeast Expressway (I-93). Logan Airport is about 20 minutes away by taxi and 30 minutes by subway and bus. The two existing intercity bus terminals, which would be incorporated into the Transportation Center, are less than a mile away.

In addition, the proposed Third Harbor Tunnel would further recommend the South Station location. Entrance to the tunnel would be only a few blocks from South Station, and it would provide a convenient connection between the Transportation Center and the airport.

## South Station Area

South Station is located in a rapidly changing area on the southeast corner of downtown Boston (see Figure 2-1). Within the last two years, two new buildings, the Post Office Annex and the Stone and Webster Building, have been completed on the east side of the Station. In the area to the north of the Station, the Blue-Cross-Blue Shield Building has been opened within the past year, and the Federal Reserve Building and 175 Federal Street are under construction.

To the west of the Station, however, along Atlantic Avenue, South Street and Lincoln Street, there is little new construction activity. In this area, known as the "leather district" some of the older commercial and office structures show a noticeable amount of deterioration. A few of these buildings have been removed but no new construction is planned at the present time. There are no plans for extensive renovation of the existing structures, though many are in good structural condition and could be handsomely restored.

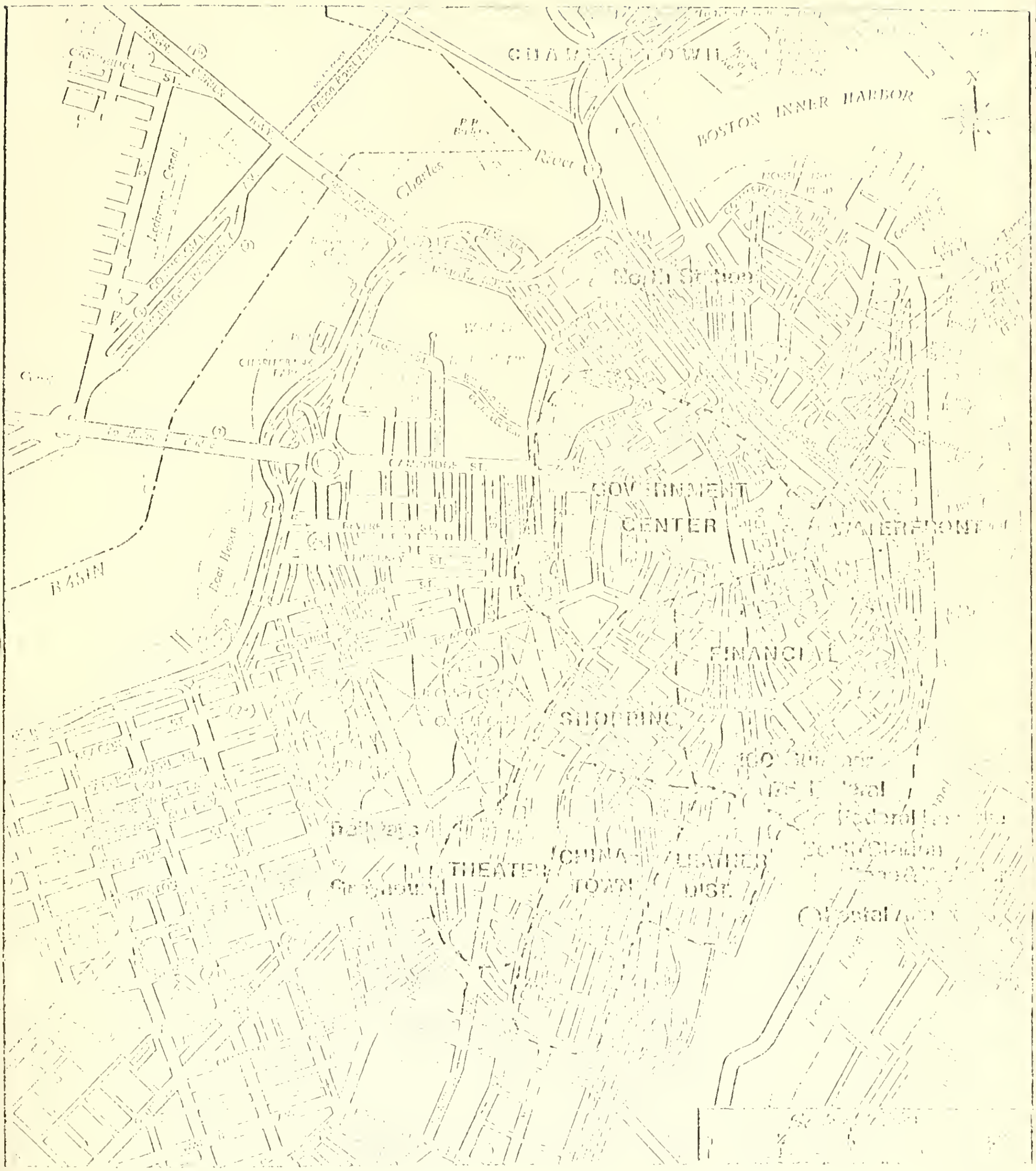


FIGURE 2-1. DOWNTOWN BOSTON

The new buildings recently completed, planned, or under construction in the immediate vicinity of South Station will increase the daytime population in the area by some 20,000 workers. Since limited parking facilities are being provided in these new facilities, a majority of the people employed can be expected to use public transportation.

These developments in the immediate vicinity would be further reinforced by construction to the east of the station across the Fort Point Channel. Recent studies have indicated that development is likely to take place on the South Boston side of the Channel. This would have implications on the Transportation Center because of increased public transportation usage and because of the additional traffic which this development would generate. This traffic would add to the congestion that already occurs in the vicinity of the South Station.

Within the 82-acre South Station Urban Renewal Area, redevelopment has been in progress since 1971. All buildings owned by the BRA have been demolished except two--the South Station Headhouse and East Wing, and the Massachusetts Envelope Building. The Headhouse and remaining portion of the East Wing are presently undergoing renovation. Plans call for the Envelope Building to be converted into a temporary bus terminal for those bus lines currently using the Trailways Terminal at Park Square.

Site Constraints

The South Station location is favorable for a Transportation Center, but the site itself has a number of constraints that will affect the design. The site is shown on Figure 2-2.

The railroad tracks and platforms will be rebuilt and relocated somewhat, but their general configuration will remain unchanged. Reflecting this, the site is long and narrow, fronting for several blocks along Atlantic Avenue. It is restricted on the west by Atlantic Avenue and on the east side by the Post Office Annex.

The existing station, at the north end of the site, poses another constraint. As the Headhouse is on the historical register, the decision has been made not to remove it or alter its facade; it must be integrated into the Transportation Center design and made to function as a principal point of entry into the Transportation Center. Because of the space needed for rail terminal functions at the head of the tracks, the Headhouse also limits the point to which the tracks can be extended toward Summer Street.

While the site is restricted on three sides by streets and buildings, it is almost open-ended on the south where the tracks and switching area extend for a considerable distance.

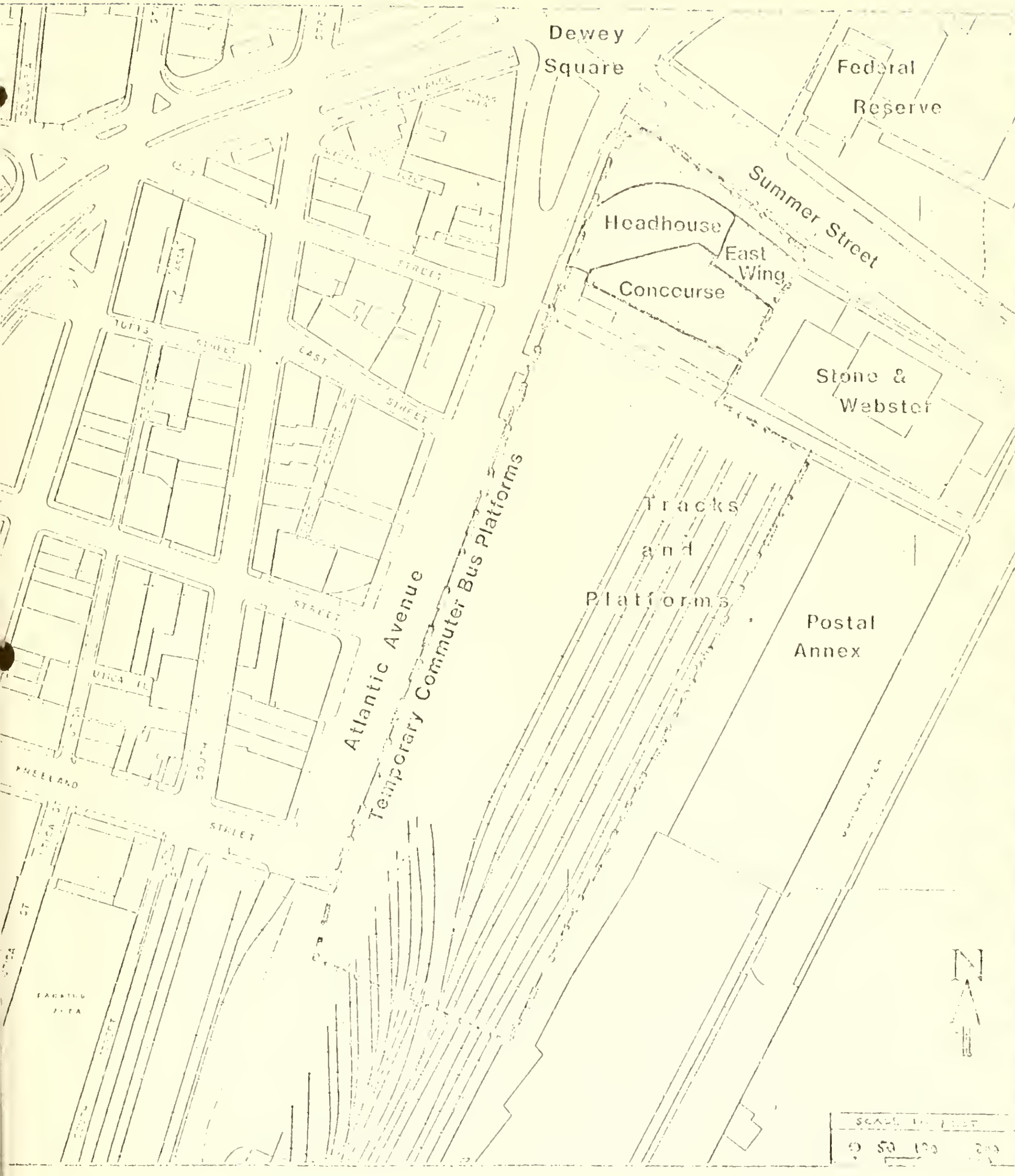


FIGURE 2-2. SOUTH STATION SITE

The rail platforms must be located north of the switching area however, and the south end of the site is inconvenient for people approaching the Transportation Center on foot or by subway.

## South Station Description

The existing railroad terminal building consists of three elements: the Headhouse, the east wing, and the concourse. Together they will total about 145,000 square feet of space, following the completion of the present renovation and demolition work being undertaken by the BRA. The five-story Headhouse has the major portion of the space (about 88,000 square feet) while the east wing will have about 28,000 square feet and the concourse 25,000.

The Headhouse, completed in 1899, is listed on the National Register of Historic Places. This listing subjects any exterior or interior alterations to review by local, state and federal agencies. The Headhouse consists of a monumental stone bearing-wall facade with steel frame and wood-plank flooring. Any major renovation (defined as totaling over 50 percent of estimated value in one year) would require alterations to the structural frame and floor to meet the appropriate fire code rating. About 50,000 square feet of the total 88,000 are now being used. The majority of space is devoted to Penn Central and Amtrak operations, while the ground floor is used by several commercial tenants.

The east wing, which once extended from the Headhouse to Fort Point Channel, will have only five bays following completion of the demolition. Construction of the east wing is similar to that of the Headhouse, and it would require similar upgrading in structural and fire rating if major renovation was undertaken. The east wing is not on the National Register, however, and can be modified or demolished without design review. Space utilization is higher in the east wing than in the Headhouse with about 23,000 of the 28,000 available square feet being used.

The concourse is a one-story structure which abuts the Headhouse and the east wing. It provides a waiting room, ticketing and transition space for passengers boarding and leaving the trains. This area is presently undergoing renovation as part of the overall station improvement project. Uses to be included in the concourse following this renovation are the stationmaster office, baggage handling, commissary, concessions, and pedestrian circulation. The waiting room and ticketing areas will be relocated in the ground floor of the east wing in part of what originally was a waiting room. The concourse is not included on the National Register and could be demolished without undergoing the review process.

Behind the concourse are the 10 stub-end tracks that are still in operation. These serve all commuter and intercity trains coming to South Station. The platforms were shortened several years ago, and the tracks now end about 100 feet from the concourse. The platforms vary in length from 450 to 950 feet. All the platforms have canopies, offering some protection from the weather. Passengers--especially those carrying baggage--experience difficulty boarding and alighting from trains because of the low-level platforms. Off-peak trains often stop at the far end of the platforms, forcing passengers into a long walk to reach the terminal.

The track area is bounded on the east by the Post Office Annex and on the west by temporary commuter bus platforms along Atlantic Avenue. The tracks are generally at elevation +25 at the concourse end and somewhat lower at the switching end of the platforms.

## Rail Service

South Station is the Boston terminal for all intercity trains and for all commuter trains on Penn Central lines to the west and southwest. A non-terminal station on the line --Back Bay Station--serves about half as many passengers as South Station.

On a daily basis, about 120 trains and 9,000 passengers enter or leave South Station. This includes 22 Amtrak intercity trains that either terminate or originate at South Station and 94 commuter trains operated by the Penn Central Railroad for the MBTA. Trains operate in and out of the station through most of the day, with the first trains departing about 5:00 a.m. and the last train at 12:20 a.m.

By far the largest segment of persons served by the station is commuters, some 3,800 daily as compared to 700 intercity passengers in each direction. About 2,800 commuters (almost 75 percent) arrive in the morning peak hour (7:50 - 8:50 a.m.). Twelve trains arrive and depart during this hour, with passenger loadings at South Station ranging from about 100 to 500 per train. Ridership during off-peak periods is very low, and most off-peak trains are single self-propelled diesel cars.

Intercity rail service is provided by Amtrak. Ten trains depart daily for New York City, seven of which continue on to Washington, D.C. Amtrak recently reinstituted rail service between Boston and Chicago, via Springfield, Albany, and Cleveland. Passenger loadings on the interstate trains are generally low, averaging fewer than 100 persons per train at South Station. Additional Boston intercity passengers use the Back Bay and Route 128 stations. Intercity ridership varies greatly on a daily and seasonal basis, with peaks on Friday and Sunday and at holiday periods. There are no freight operations at South Station, and baggage handling and checking facilities are limited.

## Bus Facilities

The intercity bus service now using the Trailways and Greyhound terminals in the Park Square area would be incorporated within the Transportation Center, as well as commuter bus service from the south and west. Bus lines using the Trailways terminal include Continental Trailways, Peter Pan, Almeida, Trombley, Grey Lines and Wellesley Fells. Ritchie buses stop nearby. Bus lines using the Greyhound terminal include Geryhound, Vermont Transit, Plymouth & Brockton (including Brush Hill) Bonanza, Englander, Hudson, Boston Commuter, Michaud and ABC.

At both of the present terminals, passenger areas are crowded, bus operating and storage space inadequate, and package express facilities limited. Relocation and consolidation of the two intercity bus terminals have been the subject of discussions and planning for many years. The Trailways terminal must be relocated before the planned Park Plaza redevelopment project can proceed, and plans have been developed to provide a temporary terminal in the South Station area.

Greyhound Terminal. The Greyhound bus terminal, located on St. James Street near Arlington Street, has eighteen sawtooth bus platforms. Greyhound uses 8 gates on one side of the terminal, and other intercity lines share the rest of the positions with commuter buses. The terminal is being renovated to improve the waiting area and baggage facilities, but it will still be crowded at peak periods, and bus operating space will remain inadequate. Buses now use the side of the bus lanes on either side of the terminal for layover space, making it difficult for buses entering and backing out of the platforms. Many of the commuter buses arriving at the Greyhound terminal during the a.m. peak period drive through the terminal, but unload in the bus lane rather than pull up to the sawtooth platforms. Passengers walk along the bus lane to reach the street, interfering with incoming buses. Buses unloading passengers sometimes block access to the terminal and cause incoming buses to back up onto St. James Street. During the evening peak period, the various bus lines must share the limited platforms in order for all departures to be accommodated.

Trailways Terminal. The Trailways terminal is located in Park Square, with the bus entrance and exit on Eliot Street. Trailways buses operate from four of the ten platforms at the terminal, but share three of these with other carriers. Peter Pan uses two platforms, one shared with Trailways. Almeida has two platforms, and during the evening peak also uses two of Trailways' platforms. The buses load two deep at those platforms. Trombley, Wellesley Fells and Grey Line each have one platform in the terminal, but most Grey Line commuter buses load and unload along Charles Street, where there is no passenger shelter. Ritchie buses load on St. James Avenue across Charles Street from the terminal. Passengers using the platforms in the terminal have to line up for boarding along the narrow platform area which is

outside of the terminal building. Occasionally buses departing from some gates must back into the street, interfering with rush hour traffic. Standby bus space is inadequate, and buses waiting to use a loading platform often stand along the streets around Park Square.

Besides using the Trailways and Greyhound terminals, some commuter or suburban bus lines currently load and unload passengers near the Essex Hotel opposite South Station and on other local streets. No shelter or services are provided for passengers at this location.

Bus Service

Because the operations of intercity and commuter buses differ, and they may be separated in the Transportation Center, it will be helpful to distringuish between the two types of operation. Some of the characteristics of commuter bus operations are heavier peak-hour schedules and passenger loads, more bus schedules on weekdays than on weekends, and shorter routes than intercity buses, usually between a large city and its suburbs or satellite cities.

The MBTA provides the most extensive commuter bus service of all operators in the region. Four MBTA express lines from the western suburbs operate via the Mass. Turnpike, with stops downtown on Summer Street near South Station and on Chauncy Street. The lines are #400 (Wellesley-Newton), #401 (Brighton), #404 (Watertown), and #405 (Waltham). The Watertown line replaces a Green Line branch that was removed from service several years ago. During the morning peak hour (8-9 a.m.) about 40 MBTA express buses arrive in the South Station area and about 32 depart during the evening peak hour. More than 3,000 passengers ride these four lines during the two-hour morning peak period.

The private carriers with the largest commuter operations to Boston are Gray Line and Plymouth & Brockton (including Brush Hill). The Gray Line uses the Trailways Terminal. Operating via the Massachusetts Turnpike, Gray Line buses serve Worcester and the rapidly growing Framingham area. Plymouth & Brockton serves the South Shore, another rapidly growing suburban area, which has been without commuter rail service since the New Haven ceased operations on the Old Colony routes in 1959. Plymouth & Brockton buses operate both from Essex Street and the Greyhound terminal.

Other bus lines providing commuter type service to the Trailways terminal include Wellesley Fells, with local service along Route 9 between Boston and Framingham, and Trombley, serving Lawrence and Andover. Almeida, with commuter-oriented service to

Middleboro and New Bedford, also offers intercity service to Cape Cod, with a considerable amount of resort traffic in summer. Trailways and Peter Pan offer intercity service only. Trailways serves Hartford, New York City and points south, and in the other direction, points in Maine and New Hampshire. Peter Pan serves Springfield and Amherst, with connections to points west.

The commuter bus operators using the Greyhound terminal, besides Plymouth & Brockton, include ABC, with local service along Route 1 between Boston and Providence; Boston Commuter serving Haverhill and Lawrence; and Hudson, serving Peabody. Bonanza and Englander schedule buses for both commuters and intercity travelers, Bonanza serving Providence, Newport and Fall River, and Englander serving Fitchburg and points west. Greyhound is the major intercity operator at its terminal, serving Hartford, New York and points south; Albany and points west; and Portland, Maine and points north. Vermont Transit provides intercity service to New Hampshire, Vermont and Montreal; and Michaud has two daily departures to Springvale, Maine.

Daily commuter bus patronage on those lines described above is estimated to be approximately 10,500 in each direction, with nearly 7,000 of the daily commuters arriving during the 7-9 a.m. peak period. The estimated daily intercity patronage is about 3,700 in each direction. Daily scheduled bus arrivals total about 560, with a similar number of departures. About 400 of these are classed as commuter type operations, and 160 are intercity. Commuter bus patronage remains fairly steady on weekdays throughout the year, but is much lower on weekends. Intercity patronage varies more throughout the year, and shows peaks on Fridays and Sundays and at holiday periods.

Public Transit

In addition to the MBTA Turnpike express buses, which are expected to use the commuter bus facilities in the Transportation Center, the South Station area is served by an MBTA rapid transit line and four local bus lines.

Rapid Transit. Rapid transit service to the area is provided by the South Station stop on the MBTA Red Line. The Red Line is the fastest and most modern in the MBTA rapid transit system. It runs between Harvard Square in Cambridge and Dorchester and Quincy. Current plans are to extend the line at both ends, northwest from Harvard Square to North Cambridge and south from Quincy Center to South Braintree.

The Red Line provides convenient interchange with the Orange Line at Washington Street, one stop from South Station, and with the Green Line at Park Street, two stops away. Scheduled

headways on the Red Line at South Station are about two minutes during peak hours and four minutes during daytime hours. At night and on weekends, headways increase up to about eight minutes. Use of the Red Line has increased since the extension to Quincy Center was opened in 1971. Passenger boardings at South Station in 1974 were about 9,000 on an average weekday.

The transit station, constructed in 1915, consists of two side-loading 350-foot platforms at elevation minus 23.8 feet. The platforms probably will have to be lengthened eventually to serve six to eight car trains. A mezzanine is constructed over the platform at elevation minus 11 feet; street grade over the station is at approximately +19 feet.

Access between the mezzanine and the platforms consists of two stairs and an escalator for each platform. From the mezzanine there are three points of access to street level. At Atlantic Avenue, stairs plus an escalator are provided. Kiosks at the Federal Reserve Building and in front of the Headhouse provide only stairs. No direct connection exists between the transit station and the Headhouse. There is one egress escalator leading directly up to street level from the southbound platform.

Local Buses. Four MBTA local bus routes either terminate or stop at South Station. Route 2 connects South Station and North Station. Route 3 connects South Station with Haymarket Square via the North End. Route 6 extends from the Army Base in South Boston to the Aquarium Station of the Blue Line, via South Station. Route 7 goes from South Station to City Point in South Boston. During the peak hour from 20 to 25 buses on these four lines stop at the South Station area. Service during the rest of the day and on weekends is very limited, indicative of the low passenger volume.

In general, MBTA policy is to use local buses to feed the rapid transit stations throughout the metropolitan area. Excluding feeder service, local buses carry only three percent of the people entering and leaving the downtown area. Bus operating conditions along the streets near South Station are generally poor, due to the irregular street pattern which permits few through routings.

Taxis and Car Rentals

Taxis are usually available at South Station at an on-street taxi stand on the Atlantic Avenue side of the terminal. An off-street taxi bay once existed on the Summer Street side of the terminal but has been abandoned.

There are no car rental facilities at the South Station terminal, though Avis does have an office at High Street. Several car

rental firms have facilities in the Park Square area, near the existing bus terminals.

Intercity rail traffic at South Station is fairly low at present, and there is little demand for kiss-and-ride facilities. Most auto dropoff and pickup activity takes place along Atlantic Avenue.

Pedestrians

During the peak periods of commuter movements, hundreds of pedestrians cross the streets and use the sidewalks in Dewey Square. This intense pedestrian usage extends along Atlantic Avenue beyond Congress Street, along Federal Street toward Post Office Square, and along Summer Street through Church Green.

Pedestrian access to South Station is particularly important, because it is a generator of a large number of pedestrian trips. An origin-destination study conducted in the Dewey Square area in 1971 indicated that South Station was the destination of about 27 percent of all pedestrian trips during the 4:30 to 5:30 p.m. peak hour. The intensity of trips as well as the dependence on South Station is estimated to have increased over the last several years with the construction of new office buildings in the vicinity. Another important point from the 1971 study was that distances walked in Boston are longer than in most cities in the United States. Railroad and bus users made the longest walk, with up to 55 percent walking further than 2,000 feet.

A recent survey of commuter rail and bus passengers, undertaken for this project, showed that more than 80 percent of the peak period commuters using South Station walk from the station to their downtown Boston destinations. A similar percentage was found among commuter bus passengers using the bus stop along Essex Street near South Station.[1]

Streets and Highways

One of the major benefits of locating a Transportation Center at South Station is accessibility to the regional transportation roadway network. However, while South Station is accessible from the major arterial highway system serving the Boston area, there are some serious circulation problems on local streets in the area of the terminal. The irregular and narrow streets, compounded by the one-way street system make vehicular travel between the terminal and other parts of the CBD difficult, particularly during peak traffic hours. Figure 2-3 shows the streets and highways in the South Station area.

1. Parsons, Brinckerhoff, Quade & Douglas, Inc. "Report of South Station Commuter Survey," for the Boston Redevelopment Authority, January 19, 1976.

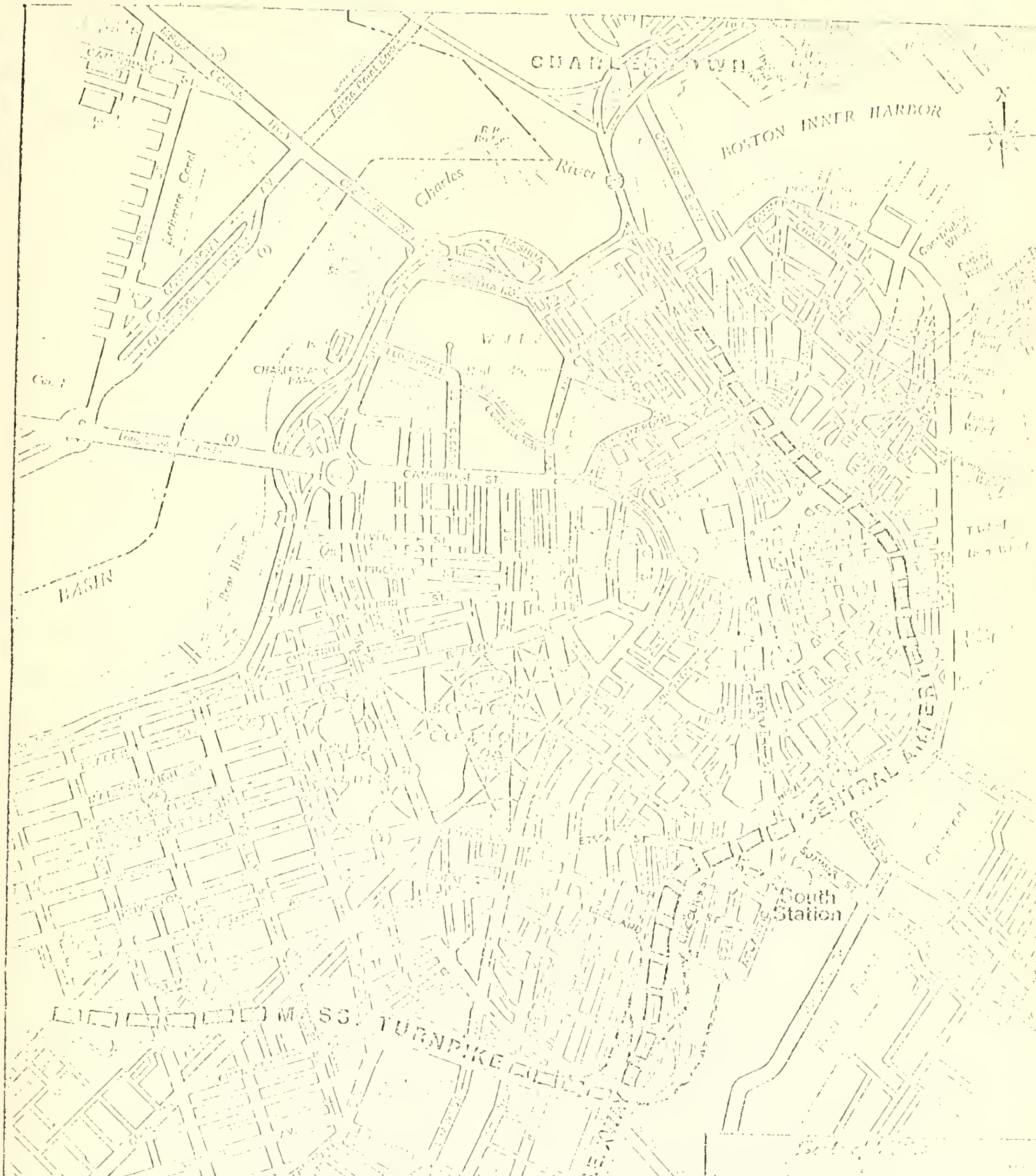


FIGURE 2-3. STREETS AND HIGHWAYS IN THE SOUTH STATION AREA

__Expressways.__ The Massachusetts Turnpike (Interstate 90) from the west meets the Southeast Expressway (recently designated Interstate 93) at a point about a half mile south of the South Station Headhouse. North of that point, the expressway, which carries traffic through downtown Boston, is known as the Central Artery (also designated Interstate 93). The Central Artery is in tunnel in the area of South Station, and passes under Dewey Square a few hundred feet from the Headhouse.

Traffic approaching the South Station area from the Southeast Expressway exits on Kneeland Street at Lincoln Street, and traffic from the Turnpike exits on Kneeland Street at South Street. In both cases, traffic proceeds easterly on Kneeland Street to Atlantic Avenue to reach South Station. In the reverse direction, traffic heading from the South Station area onto the Southeast Expressway or onto the Turnpike enters from Kneeland Street at the Surface Artery. Traffic can also access the Central Artery southbound by a ramp from Purchase Street at Congress Street, a block north of South Station, and from there proceed onto either the Southeast Expressway or the Turnpike.

Traffic approaching South Station from the north, southbound on the Central Artery, exits onto Summer Street at Dewey Square, right in front of the Headhouse. In the reverse direction, traffic from the South Station area enters the Central Artery northbound using a ramp from Atlantic Avenue near Congress Street.

The expressway system provides fast, convenient access between the South Station area and most parts of the metropolitan area throughout much of the day. During peak hours, however, the Southeast Expressway and the Central Artery are often congested and traffic moves slowly in both directions. On the Turnpike, traffic is heavy during peak hours, but it generally moves smoothly unless there is an unusual tieup.

__Local Streets.__ Federal Street and Congress Street connect South Station with the financial district to the north. Summer Street and Essex Street connect with the retail district to the west. Beach and Kneeland Streets pass through Chinatown on their way to Park Square and Back Bay. Summer Street and Broadway are principal connectors crossing the Fort Point Channel to South Boston to the east.

Atlantic Avenue, Purchase Street and the Surface Artery serve as frontage roads for the Central Artery, which passes under Dewey Square, and provide access to the north. South Street and Lincoln Street traverse the leather district in a north-south direction to the west of the station. Access to the south and the southwest is provided on Kneeland, South and Purchase Streets, Atlantic Avenue and the Surface Artery.

Traffic on the streets in the vicinity of South Station is related more to the location of the area in respect to the generators in downtown Boston than to generators within the area itself. Most of the trips are through trips, to and from other sections of the city. The street network is a tight urban system. One major constraint is expressway access. Much of the expressway mainline and ramps are presently operating at capacity and cannot accommodate additional traffic in the peak hours. This is particularly significant because the prime access to the Center for both the commuter buses and the auto parkers is from the expressway and turnpike.

One block from South Station, where Summer Street and the Surface Artery intersect at Dewey Square, there is a major traffic congestion and vehicular-pedestrian conflict. The conflict can be attributed to the width of the intersection, the complex traffic channelization, and the lack of proper traffic-control devices. Traffic congestion also occurs immediately in front of the terminal, particularly during peak hours. At many locations, streets have been operating at capacity for many years. A comparison of cordon counts taken in 1964 and 1974 indicates a 20 percent increase in passengers cars entering the downtown area. The effect is that peak period traffic is occupying a wider time band. In the nearby industrial and commercial areas, some of the relatively minor nodes of transportation tend to dominate the street function. Curb-lane use by trucks, buses and taxis and illegal parking and double parking reduce the carrying capacity of even wide streets by a large amount. Also on-street truck loading reduces the capacity. There have been several restrictions in the circulation in the area due to the loss of Dorchester Avenue to through traffic. In addition, there are restrictions at several of the intersections that lead into the area. The street network--both local streets and regional expressways--is barely adequate to accommodate the present traffic volumes.

Parking

There are about 4,500 off-street parking spaces within a quarter-mile of South Station. These spaces, which are not provided as part of the terminal operation, are located in about 35 separate parking lots or garages available for public parking, including two lots operated by the BRA. Over half of the lots have capacities of less than 100 cars. Daily parking rates are under $3.00.

Legal on-street parking spaces in the area are metered. Parking is generally restricted to one hour, and the meter rate is a quarter per half hour. On-street spaces are not intended for commuter parking, and parking at many of the metered spaces is prohibited during one or both peak periods.

Illegal curb parking and double parking is common in the area around South Station, as it is throughout the metropolitan area.

Proposed Improvements

A number of improvements to the existing transportation system that would have an effect on the Transportation Center are either under study or in the process of being implemented.

Local street improvements in the South Station area will ease access to the Transportation Center. The Dewey Square intersection is being redesignated to facilitate vehicle and pedestrian flow. The Turnpike exit at South Street will be moved to Atlantic Avenue, and Atlantic Avenue will be made one-way northbound. South Street will be made one-way southbound, and a new Turnpike on-ramp will be added at Kneeland Street. Essex Street will be widened and made two-way.

Under serious consideration on the state level is a proposal to depress the Central Artery to improve traffic flow. This might involve making the present tunnel at Dewey Square southbound only and constructing a new northbound roadway to the east of South Station. Related to the Central Artery project is a proposal for a third tunnel under the Boston Harbor. As proposed by the Governor following the Boston Transportation Planning Review[1] in 1972, this would be a limited use tunnel, connected directly to Logan Airport. Such a facility would make the airline ticketing, limosine and check-in function of the Transportation Center more important. Any design of access ramps to the Transportation Center must be compatible with possible configurations for a depressed Central Artery and a third harbor tunnel.

Both state and city policy is to encourage people working in Boston to commute by public transit. The MBTA is currently studying a program of shuttle buses to improve downtown distribution. Alternative methods of improving distribution from the regional intercity and commuter terminals are also under investigation. As part of the Central Artery study, a possible rail connection between South Station and North Station will be investigated further. In addition to these proposals, improvement programs are underway for the MBTA rapid transit system, with renovations of Green Line stations and extensions to the Red, Orange and Blue lines.

Proposed improvements in intercity and commuter bus and rail service are discussed in Chapter 3.

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1. Boston Transportation Planning Review, Harbor Crossing Draft Environmental Impact Statement, September 1972

## CHAPTER 3 - DEMAND PROJECTIONS

In order to design the Transportation Center, design-day and peak-period vehicle and passenger volumes must be established. This chapter provides those patronage estimates for 1990, the year used by the FRA in estimating Northeast Corridor high-speed rail patronage.

The process of preparing these forecasts has been detailed in a series of technical memoranda prepared for the BRA for Parsons, Brinckerhoff, Quade & Douglas.[1] Summary results of these analyses are presented in the following pages.

### Rail Passenger Projections

Intercity Rail. The Federal Railroad Administration's Task 1 Demand Analysis[2] forecast 1990 ridership on the high-speed rail service planned to connect the Northeast Corridor cities along the eastern seaboard. The FRA methodology was to forecast total travel demand between pairs of Northeast Corridor cities, based on population growth and growth in disposable income. Trips between each city pair were distributed among the various travel modes, with reference to travel time and other modal characteristics. A three-hour rail travel time was assumed between Boston and New York, with corresponding service improvements to other cities. The FRA analysis forecast a high of 6,816,000 and a low of 3,835,000 rail person trips in 1990 between Boston and other Northeast Corridor cities.

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1. Op.Cit., Parsons, Brinckerhoff, Quade & Douglas, Inc. "Technical Memoranda".

2. Bechtel, Inc., Northeast Corridor High Speed Rail Passenger Service Improvement Project. Task 1--Demand Analysis, prepared for the Federal Railroad Administration, April 1975.

PBQ&D Technical Memorandum #1 revised the number of total 1990 intercity trips, based on more recent population forecasts. The three-hour rail travel time between Boston and New York assumed in the FRA analysis no longer appears attainable by 1990. Recent legislation and policy statements by the Secretary of Transportation indicate that a travel time of 3 1/2 to 4 hours is more reasonable. Other anticipated service improvements, such as passenger comfort and better station facilities, will still be met by 1990. Using the revised travel forecast, and a revised modal split based on the revised trip times, a new forecast of 1990 rail person trips to and from Boston was obtained: a high of 5,029,000, a low of 2,300,000, and a likely estimate of 3,023,000. Fifteen percent of these passengers were assumed to use the Route 128 station in Dedham, leaving a probable total of 2,570,000 passengers using a downtown Boston station.

The FRA analysis suggests that 0.38 percent of annual patronage be used as design day patronage on the New York-Washington segment. The PBQ&D Technical memorandum suggests that 0.5 percent of annual patronage be used to estimate design-day patronage at Boston, because of the greater day-to-day variations on this segment. This yields a design-day intercity rail patronage of 6425 arrivals and 6425 departures, or a total of 12,850 in both directions.

It should be noted that these design-day patronage estimates assume that all intercity rail passengers will use the South Station Transportation Center and that no intercity trains will stop at Back Bay Station.

Commuter Rail. The 1990 commuter rail patronage forecasts are discussed in Technical Memorandum #3. The 1980 inbound commuter rail ridership on the Penn Central lines was estimated by the Central Transportation Planning Staff to be 7,050 passengers, of whom 4,700 will disembark at South Station. Factors were applied to this estimate to account for expected changes in population and in commuter rail policy and service between 1980 and 1990. The annual average weekday ridership then was multiplied by 1.12, to yield the design day patronage estimate, approximating daily ridership during February, the busiest month for commuter ridership. To this was added a number to account for patronage attracted by CBD employment shifts expected to make the South Station more convenient for many downtown workers.

The resulting design-day projections for rail commuters using South Station range from a low of 4,100 to a high of 10,000. The likely design-day patronage is 7,000 arrivals and 7,000 departures, a total of 14,000 in both directions.

## Bus Passenger Projections

The process of estimating 1990 commuter and intercity bus patronage is described in Technical Memorandum #2. Current bus patronage was estimated on the basis of bus schedules, cordon count data, and information supplied by the MBTA. For the purpose of the analysis, patronage was split into intercity and commuter passengers, and a separate forecasting process was carried out for each.

Intercity Bus. The intercity bus patronage projections were prepared separately for trips in the Northeast Corridor, where high-speed rail service could be expected to divert travelers from bus to rail, and for non-corridor trips, where no diversion is expected.

For the Northeast Corridor, the process of forecasting bus patronage was the same as for rail patronage. The total number of person trips by bus between Boston and each city was estimated on the basis of population and income growth and modal split percentages. The number of annual Northeast Corridor bus person trips for 1990 ranged from 894,000 to 1,172,000 with a likely value of 927,000.

For non-corridor bus trips, where there would be no diversion because of high-speed rail, growth multipliers were applied directly to the estimated 1974 patronage to give 1990 patronage. Estimates range from 2,361,000 to 3,096,000, with the value of 2,449,000 the most likely.

Combining corridor and non-corridor intercity bus patronage gives a total 1990 patronage ranging from a low of 3,255,000 to a high of 4,268,000 bus person trips, with 3,376,000 most likely.

As for intercity rail, design-day patronage for intercity buses was established at 0.5 percent of annual patronage, giving a likely 1990 design-day intercity bus patronage of 17,000;or 8,500 arrivals and 8,500 departures.

Commuter Bus. Commuter bus ridership for 1975 was estimated from cordon count data for private bus lines and from data supplied by the MBTA for the MBTA Turnpike express bus lines. Growth multipliers were applied to these figures, accounting for project employment and population changes and anticipated shifts in commuting habits, in order to project 1990 commuter bus patronage.

The cordon count data was obtained in June. For a design-day estimate reflecting ridership during the commuter peak month of February, a design-day factor was applied to the figures for ridership on private lines. Since the MBTA ridership data was for a February day, no design-day adjustment was necessary.

The MBTA and non-MBTA ridership figures were combined, and an adjustment made to account for the expected locational shifts in CBD employment that would make the South Station destination more convenient. This yielded a 1990 design-day commuter bus forecast ranging from a low of 23,800 to a high of 56,800, with a likely estimate of 35,000; or 17,500 arriving and 17,500 departing design-day commuter bus passengers.

## Peak Period Volumes

For design of passenger and vehicle facilities within the Transportation Center, it will generally be necessary to use peak-period volumes rather than daily volumes.

Commuter Rail. Commuter rail shows the sharpest peaking of any mode using the Transportation Center. Using recent ridership data, during the morning peak period, 73 percent of daily arrivals were on trains scheduled to arrive during one hour (7:55 to 8:54), 59 percent during a half hour, and 44 percent during a single 15-minute period. In the afternoon, 66 percent of daily departing riders were on trains leaving during one hour (4:45 to 5:54), 52 percent during a half hour, and 45 percent during a 15-minute period.

With increases in patronage, much of the additional ridership could be expected to occur outside of the peak periods, when facilities are less crowded. The following peaking factors were used to establish peak-period volumes for commuter rail: 60 percent of daily arrivals or departures during the peak hour, 50 percent during the peak half hour, and 40 percent during the peak 15 minutes. In the off-peak direction, current patronage is very low. For 1990, off-peak patronage was arbitrarily set at one percent of daily volume for each period--hour, half hour and 15 minutes.

Intercity Rail. The peaking factors for intercity rail are based on the FRA analyses. During the morning peak hour, arrivals and departures are set at 11 percent of daily volumes. During the afternoon peak period, when the intercity departure peak would correspond with the commuter departure peak, intercity departures would be 15 percent of daily volumes, and intercity arrivals 11 percent of daily.

Peak half-hour volumes are estimated at 65 percent of peak hour volumes. Since these are based on a single train movement, 15-minute peak volumes for intercity rail would be the same as half-hour peak volumes.

Commuter Bus. For commuter buses, based on current schedules and ridership estimates, 35 percent of daily arrivals or departures are assumed to occur during the peak hour, 20 percent during the peak half hour, and 12 percent during the peak 15 minutes. In the off-peak direction, patronage during the peak hour is arbitrarily set at five percent of daily volume, during the peak half-hour three percent, and during the peak 15 minutes two percent.

Intercity Bus. For intercity buses, the peak period for arrivals and departures was assumed to correspond with the afternoon commuter peak departure period. During the peak hour, intercity arrivals and departures are set at 15 percent of daily volumes. During the morning peak hour, intercity arrivals are set at 10 percent of daily volumes. Peak half-hour volumes are set at 65 percent of peak hour volumes, and 15-minute volumes at 35 percent of peak hour.

Passenger Volumes. The peaking factors discussed above are applied to the 1990 design-day patronage projections. The resulting daily and 15-minute peak-period volumes for the principal modes are presented in Table 3-1.

## Submode Split

An estimate of the modes of access to and from the Transportation Center for intercity and commuter rail and bus passengers is necessary to design facilities for local access. Commuters and intercity travelers have quite different access patterns, but the mode split is assumed to be the same for both rail and bus commuters, and for both intercity rail and intercity bus passengers.

Commuters. The modes of access for rail and bus commuters were determined in a survey conducted by Parsons Brinckerhoff Quade & Douglas, Inc. in November 1975. That survey found that 82 percent of rail commuters to South Station walk to their downtown destination, 10 percent use the subway, seven percent a local bus, and less than one percent a taxi. Similar percentages were found for bus commuters to Essex Street near South Station.

The survey was conducted on a day when the weather was ideal for walking. To account for greater use of subways and local buses during bad weather, the submode percentages for subway and bus were raised somewhat from those found by the survey. The resulting modal split design percentages are shown in Table 3-2.

TABLE 3-1

DESIGN PASSENGER VOLUMES

| | | Rail | | Bus | | |
|---|---|---|---|---|---|---|
| | | Commuter | Intercity | Commuter | Intercity | Total |
| | Arrivals | 7,000 | 6,425 | 17,500 | 8,500 | 38,925 |
| Design Day | Departures | 7,000 | 6,425 | 17,500 | 3,500 | 38,925 |
| Peak a.m. | Arrivals | 4,200 | 700 | 6,125 | 850 | 11,825 |
| Hour | Departures | 70 | 700 | 875 | 850 | 2,445 |
| Peak a.m. | Arrivals | 2,800 | 430 | 2,100 | 300 | 5,630 |
| 15-Min. | Departures | 70 | 450 | 350 | 300 | 1,150 |
| Peak p.m. | Arrivals | 70 | 700* | 875 | 1,280 | 2,845 |
| Hour | Departures | 4,200 | 1,000 | 6,125 | 1,280 | 12,525 |
| Peak p.m. | Arrivals | 70 | 450* | 350 | 450 | 1,290 |
| 15-Min. | Departures | 2,300 | 650 | 2,100 | 450 | 5,970 |

* The peak period for intercity rail arrivals does not occur at the same time as the commuter peak. During the intercity peak hour, 1,000 passengers would arrive, and during the peak 15 minutes 650 would arrive.

TABLE 3-2

SUBMODE DESIGN PERCENTAGES

| | Commuter Rail & Bus | Intercity Rail | Intercity Bus |
|---|---|---|---|
| Walk | 72 | 10 | 10 |
| Subway | 15 | 35 | 40 |
| Local Bus | 10 | 5 | 5 |
| Taxi | 1 | 10 | 10 |
| Kiss-and-Ride | 0 | 20 | 20 |
| Park-and-Ride (Long Term) | 0 | 8 | 3 |
| Intra-Terminal | 2 | 12 | 12 |

Intercity. The FRA Task 7a Report[3] presented modal split percentages for each Northeast Corridor rail terminal, but suggested that the percentages be revised to reflect conditions at the terminal. For Boston, the estimated number of kiss-and-ride passengers appeared low, and that for local bus appeared high for South Station, which has limited local bus service.

Based on observed conditions in Boston, and on modal split data for the Port Authority bus terminal in New York, the modal split design percentages for intercity bus and rail passengers at the Transportation Center were adjusted and are shown in Table 3-2.

## Vehicle Volumes

Three kinds of vehicle volumes have major implications for Transportation Center design--buses and trains entering and leaving the Transportation Center, taxis and private autos transporting passengers to and from the Center, and commuter parking.

Bus and Train Volumes. Amtrak's 1975 passenger schedule had 10 daily trains in each direction between New York and Boston, departing every hour or two during the day, and one daily train to and from Springfield and points west. The FRA Task 7a report anticipates that in 1990 there will be two trains per hour serving Boston in each direction along the Northeast Corridor. In addition, there may be a limited number of non-corridor intercity trains, serving such places as Springfield, Cape Cod, and northern New England.

The commuter train schedule in 1990 probably will not differ greatly from the present schedule, since cars can be added to most trains to carry anticipated increases in patronage. The current schedule shows 42 commuter trains arriving and the same number departing on weekdays. Eleven commuter trains arrive during the peak hour in the morning and 11 depart during the peak hour in the afternoon. Table 3-3 shows an estimate of 1990 daily and peak period train movements.

The estimate of 1990 bus movements was based on current schedules and 1990 ridership forecasts. The numbers of daily and peak period bus arrivals and departures are shown in Table 3-4.

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3. DC/STV, Inc. (De Leuw Cather & Company and STV), Northeast Corridor High Speed Rail Passenger Service Improvement Project, Task 7A--Terminals, for the Federal Railroad Administration, May 1975.

TABLE 3-3

1990 TRAIN ARRIVALS AND DEPARTURES

| | Arrivals | | | Departures | | |
|---|---|---|---|---|---|---|
| | Commuter | Intercity | Total | Commuter | Intercity | Total |
| Design Day | 45 | 30 | 75 | 45 | 30 | 75 |
| A.M. Peak Hour | 12 | 1 | 13 | 2 | 2 | 4 |
| A.M. Peak 15 Minutes | 5 | 1 | 6 | 1 | 1 | 2 |
| P.M. Peak Hour | 2 | 3 | 5 | 12 | 3 | 15 |
| P.M. Peak 15 Minutes | 1 | 1 | 1 | 5 | 1 | 6 |

TABLE 3-4

1990 BUS ARRIVALS AND DEPARTURES

| | Arrivals | | | Departures | | |
|---|---|---|---|---|---|---|
| | Commuter | Intercity | Total | Commuter | Intercity | Total |
| Design Day | 661 | 251 | 918 | 661 | 257 | 918 |
| A.M. Peak Hour | 175 | 26 | 201 | 44 | 26 | 70 |
| A.M. Peak 15 Minutes | 60 | 9 | 69 | 18 | 9 | 27 |
| P.M. Peak Hour | 44 | 39 | 83 | 175 | 39 | 214 |
| P.M. Peak 15 Minutes | 18 | 14 | 32 | 60 | 14 | 74 |

Automobiles and Taxis. Automobile and taxi movements to and from the Transportation Center were determined from the passenger volumes in Table 3-1 and the submode percentages in Table 3-2. The design vehicle volumes for the 15-minute peak periods are shown in Table 3-5. For each category, the volume given is for the 15-minute period during the day with the highest combined commuter and intercity ridership.

In computing Table 3-5, the following assumptions were made:

(1) each automobile and taxi would carry an average of 1.5 terminal patrons,
(2) of the automobiles meeting arriving passengers (kiss-and-ride), half would use short-term parking and half would use curbside pickup,
(3) of the automobiles bringing departing kiss-and-ride passengers, one-third would use short-term parking and two-thirds would use curbside dropoff.

It should be noted that the proportion of kiss-and-ride passengers using curbside access and short-term parking will depend largely on Transportation Center design, especially the location of curbside and short-term parking with respect to each terminal.

The number of automobiles entering and leaving long-term parking in Table 3-5 includes intercity travelers only, and not commuters or other visitors to facilities in the South Station area who would use the additional spaces provided by a large parking garage.

Other vehicle movements that must be considered in Transportation Center design, but for which volumes are not available, include package express dropoff and pickup, and delivery of goods and supplies.

Commuter Parking. Development of a Transportation Center, with its need for passenger parking and ramp access to the expressway network, provides an opportunity to relocate scattered existing commuter parking to a new garage associated with the Center. This parking facility would capture commuters at the edge of the CBD, thereby reducing automobile traffic on local streets.

Demand for parking in downtown Boston will exceed supply--currently frozen by EPA regulations--by 9,000-11,000 spaces in 1985. As many as 5,000 spaces within walking distance of South Station could be eliminated and relocated at the Transportation Center, with the desired result of reducing downtown congestion. In reality, however, the size of the commuter parking facility at South Station will be determined by site limitations and design considerations, rather than by market demand. Currently, the expectation at BRA is that the parking facility, combining terminal parking and commuter parking, should accommodate approximately 2,500 vehicles. The amount of parking space required for Transportation Center patrons will be discussed in Chapter 5.

TABLE 3-5

15-MINUTE PEAK VEHICLE VOLUMES

| | Curbside Access | | | | Parking | | |
|---|---|---|---|---|---|---|---|
| | Taxi | | Auto | | Short | Long Term | |
| | Dropoff | Pickup | Dropoff | Pickup | Term | Enter | Exit |
| Rail Terminal | 62 | 49 | 58 | 43 | 72 | 35 | 35 |
| Bus Terminal | 44 | 34 | 40 | 30 | 50 | 9 | 9 |

TABLE 3-6

APPROACH ROUTES TO TRANSPORTATION CENTER

| Route | Percent |
|---|---|
| Kneeland St. | 11 |
| Massachusetts Turnpike | 11 |
| Local Streets from North | 15 |
| Expressway from North | 20 |
| Summer St., Congress St. & Northern Ave. Bridges | 5 |
| Local Streets from South | 12 |
| Expressway from South | 26 |
| | 100 |

## Approach Routes

Approach routes used by cars to the Transportation Center garage have been analyzed with reference to the 1974 downtown Boston cordon count. In distributing parkers among various access routes, it is assumed that they will approach via the Southeast Espressway, the Central Artery, the Massachusetts Turnpike, and local streets in numbers approximately proportional to the numbers using these access routes to the CBD. Table 3-6 gives the estimated access by each route, either with or without direct ramps provided to the garage from the Central Artery and Turnpike.

## CHAPTER 4 -- TRANSPORTATION CENTER COMPONENTS

This chapter discusses the major components that will be included in the Transportation Center and the functional relationships among them. The space requirements for each component are presented in Chapter 5.

### Transportation Facilities

The nucleus of a Transporation Center exists in the South Station railroad terminal. An expanded railroad operation will be combined with bus terminal operations and other compatible transportation and related facilities. Besides providing interchange among these facilities, the Transportation Center should allow each element to function as smoothly and efficiently as possible. The following paragraphs describe the major elements that would be included in the Transportation Center and how they would interact.

Rail. South Station is the terminal for all of Boston's intercity rail service and one of two terminals for commuter trains. Improvements in intercity railroad operations and service are being planned by the Federal government as part of the Northeast Corridor project, a multi-billion dollar effort to provide reliable, high-speed rail service connecting the cities along the populous Northeastern seaboard. The Massachusetts Bay Transportation Authority, which operates commuter trains to Boston, is planning to upgrade that service as well. At South Station, changes will be made in track alignment and elevation, and high-level platforms will be provided in order to conform with Federal Railroad Administration standards for the Northeast Corridor project.

The rail terminal will serve both intercity and commuter trains, and must accomodate the normal ticketing and passenger waiting and service areas. For the commuter function, the terminal must provide convenient access to downtown, to which most commuters walk.

The intercity terminal requires long term parking, auto and taxi dropoff and pickup, and a connection to the subway system. The rail terminal must also accommodate checked, carry-on, and express baggage service.

Bus. The Transportation Center will accommodate all intercity and most commuter bus service to and from downtown Boston. It will consolidate the operations of the Trailways and Greyhound bus terminals, presently located in the Park Square area.

While it should be an integral part of the Transportation Center, with convenient interchange with other nodes, the bus terminal portion of the Transportation Center should have its own identity. The bus terminal portions of the Transportation Center should provide for all of the functions that would normally be found in a free-standing bus terminal, such as passenger ticketing and waiting, newsstand, food services and other passenger conveniences, bus loading platforms and standby spaces, and baggage and package express facilities.

Beyond having a separate identity from the rail terminal portion of the Transportation Center, the bus terminal should provide separate spaces for at least two major intercity carriers, Greyhound and Trailways. Nationwide, Greyhound is a consolidated corporation, while Trailways is made up of a number of smaller operators using the Trailways name. In the Boston area, Trailways has a smaller operation than Greyhound and has smaller overall space requirements. But because they operate on many of the same routes, the two companies are quite competitive and probably will not be amenable to sharing any facilities other than a common waiting room. Separate but equally desirable ticketing, baggage and administration and operations will have to be provided for the two carriers. Some of the other intercity lines work closely with Trailways or Greyhound and will share facilities with them, while other lines may want separate facilities for ticketing and operations.

The bus terminal will accommodate both intercity and commuter bus operations. Because the delineation between the two is not always clear, separate intercity and commuter terminals are not desirable. More flexibility is achieved with a single terminal for all bus operations, but with two types of platforms. Sawtooth loading platforms with doors or gates directly off the waiting area are needed for intercity buses. Parallel or pull-through platforms, without a separate large waiting area, are better for the quicker-loading commuter bus operations. Both types of platforms should be readily accessible to the ticketing area, shops, and food services. The commuter platforms should offer direct access to the street and CBD, while it is more important that the intercity bus platform and waiting area be convenient to auto and taxi pickup and dropoff and short-term parking.

On the vehicle side, buses should be able to travel quickly and easily between the terminal and the nearby Turnpike and expressway as well as city streets. Direct ramps for buses from the expressways are a desirable feature, but would not be required, as long as the city streets were redesigned to carry buses quickly between the expressways and the Transportation Center. Within the terminal, buses should be able to circulate from the intercity to the commuter platforms and vice-versa. Standby spaces for buses should be provided within sight of both types of platforms. On-site storage for bus layovers should be provided as space allows, recognizing that off-site storage may be necessary for longer-term bus layovers.

As package express is an important revenue producer for bus lines, an area for baggage handling and package express should be provided, with separate facilities for Greyhound and Trailways. The package express area should be easily accessible from local streets and should provide space for cars and vans to park while dropping off or picking up parcels and baggage.

Automobile Access. Curb space for dropoff and pickup of passengers by private autobobiles and taxis should be convenient to the intercity rail and bus facilities. Separate loading/unloading areas for private automobiles would be desirable for rail passengers and bus passengers, and access to each should be clearly marked from the local streets and expressway ramps. It will not be necessary to segregate arrival and departure traffic, since bus and rail terminals do not separate arriving and departing passengers as air terminals do. The pickup and dropoff areas should be removed far enough from the local streets that cars waiting to find curb space will not interfere with local traffic.

Taxis could deliver rail and bus passengers at the same curb spaces as private automobiles, or at an exclusive taxi unload area. For taxis picking up arriving passengers, a separate taxi loading area should be provided, segregated from private automobiles and with adequate space for taxi queueing. A single taxi loading area for the entire Transportation Center would allow more efficient taxi operations and provide better control for waiting taxis. The taxi loading area should be clearly marked for arriving passengers in the terminal, and should be easily reached by both bus and rail passengers.

Short-term parking areas are needed for visitors dropping off passengers or meeting arriving passengers. Separate short-term parking spaces could be provided for rail and bus passengers, or there could be a combined short-term parking area, convenient to both terminals. Roadways should allow circulation between the short-term parking areas and curb side pickup.

Mass Transit. The South Station stop on the MBTA Red Line subway is located near the Transportation Center site. Direct access to the subway should allow passengers to walk between the subway and the Transportation Center without being exposed to the weather. Walking distances between the subway and the rail and bus terminals should be kept as short as possible, and clear directions to the subway should be provided for arriving passengers.

Several local MBTA bus lines will serve the Transportation Center. These buses should remain on the local streets instead of using the bus terminal. Curbside loading areas should be covered and protected from the weather, with heated waiting areas.

Parking. A major part of the Transportation Center will be a parking garage, offering both long-term parking for intercity rail and bus travelers and day parking for commuters and visitors to shops and businesses in the area. The long-term parking area should be secure and patrolled so that people will not be afraid to leave their cars overnight. Access between the garage and the bus and rail terminals should be convenient and direct. Elevators and passageways should accormodate passengers carrying baggage. For both long-term and commuter parking, direct automobile access ramps from the expressways are desireable, but not required.

Car Rental. Some intercity rail and bus passengers, especially business people, will require rental cars for local transportation in the Boston area. Car rental counters for several rental agencies should be convenient to both the bus and rail terminals. Parking space also will be needed in the Transportation Center where car rental customers can pick up and drop off their rental cars.

Airlines. For the Transportation Center to function as a true intermodal facility, it must allow connection with airlines at Logan Airport. The Draft Master Plan for Logan International Airport[1] states that Massport policy will be to expand bus and limosine service to the airport. At the least, the Transportation Center should have airline ticket offices and nearby curb space for limosines or shuttle buses to the airport.

Eventually, it may be desirable to accomplish remote airline check in at the Transportation Center. In that case, airline baggage facilities will be needed, as well as bus/limo facilities. Design of the Transportation Center should provide flexibility for future airport passenger and baggage check in.

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1. Massachusetts Port Authority, Draft Master Plan for Logan International Airport, January 1976.

Modal Interchange. For the Transportation Center to fulfill its purpose as a multimodal facility, convenient interchange among the many transportation modes must be provided. This includes interchange between local transportation modes and intercity modes, and among the various intercity modes--rail, bus, and airline.

Walking distances between modes should be kept to a minimum. Where a change in level is required, this change should all be in one direction, not, for example, up and then down. Mechanical systems, such as elevators and escalators, should be used where possible. These systems, stairs, and corridors must be designed to accommodate passengers carrying baggage.

Because of the several modes involved, it would be desirable to have as a focal point a central mixing area convenient to all modes. This would enable travelers to get their bearings and find their way throughout the Transportation Center. Information on schedules, fares, etc., should be posted in this area.

Connection should be provided among the various baggage handling areas, to allow for possible interline and intermodal exchange of baggage. Amtrak and the bus lines are exploring joint ticketing arrangements and may eventually provide joint checked baggage service.

Related Facilities.

To be successful, the Transportation Center must also have facilities which are not directly required for transportation, but which will make the Center a more pleasant and exciting place for travelers and visitors alike. These include food services, shops, and personal services.

The Transportation Center should include a range of food services, including perhaps stand-up lunch counters for commuters and travelers in a hurry, take-out deli counters for bus and train travelers, full-service restaurants ranging from inexpensive to luxury, and cocktail lounges.

Retail shops may include newsstands, drug stores, and gift shops. Florists, fruit vendors, and bakeries are desireable for the colors and smells they contribute as much as for the goods they sell.

Personal service establishments should include barbers, shoe repair, cleaners, banks and a postal substation. A mini-cinema and amusement area would serve travelers with time between connections. Non-commercial services are also needed, such as information booths, city and state visitors centers, and hotel reservation service.

The location of these facilities will depend on the type of goods or services offered. Newsstands and fast food counters would be situated at several places around the Transportation Center,

while a larger restaurant or specialty store would not be tied to a particular terminal but would be located where it could serve all Transportation Center patrons. Services such as cleaners and shoe repair, which principally serve commuters, should be on ground level near the street entrance.

## Functional Relationships

Figures 4-1 and 4-2 are conceptual flow diagrams for the rail terminal and bus terminal portions of the Transportation Center. These diagrams illustrate some of the functional relationships that should be accommodated in the Transportation Center design.

Circles represent functional areas within the terminal. Arrows represent flows--white for passengers, black for vehicles, and shaded for supplies and baggage.

The concourse is the heart of the terminal. The train or bus gates are directly connected to it, as are spaces for ticketing, food and shops, and passenger services. A separate waiting room may be desirable, away from the busy concourse, but it should connect closely with the departure gates.

For the bus terminal, the concourse and waiting area, while shown as separate in the flow diagram, are closely connected and may coexist in one large space. Leading directly from the bus waiting area are the gates to two types of bus platforms--intercity and commuter. For the commuter platforms, direct access to the street is needed as well as access to the concourse.

Access from the street and local transit could be to a common point within the Transportation Center, and from there to either the bus terminal or the rail terminal. A single long-term parking and car rental area could serve the entire Transportation Center, but separate areas of and space for auto pickup and dropoff may be needed for the rail terminal and for the bus terminal. Taxis could drop passengers at separate train or bus curbs, but a single loading area to pick up fares from the entire Transportation Center would be more efficient for taxi operators.

For commuters, direct connections between the train or bus platforms and the street are desirable. There is less need for services and facilities for the commuter passengers, and no need for them to pass through a ticketing and baggage check area before reaching the trains and buses.

In both the train and intercity bus terminals, separate access areas should be provided for parcel express and passenger baggage These services should be dispensed from a single baggage facility that handles both passenger baggage and package express. A single baggage area is shown in the bus terminal flow diagram, although in reality, in the bus terminal Greyhound and Trailways would have separate facilities.

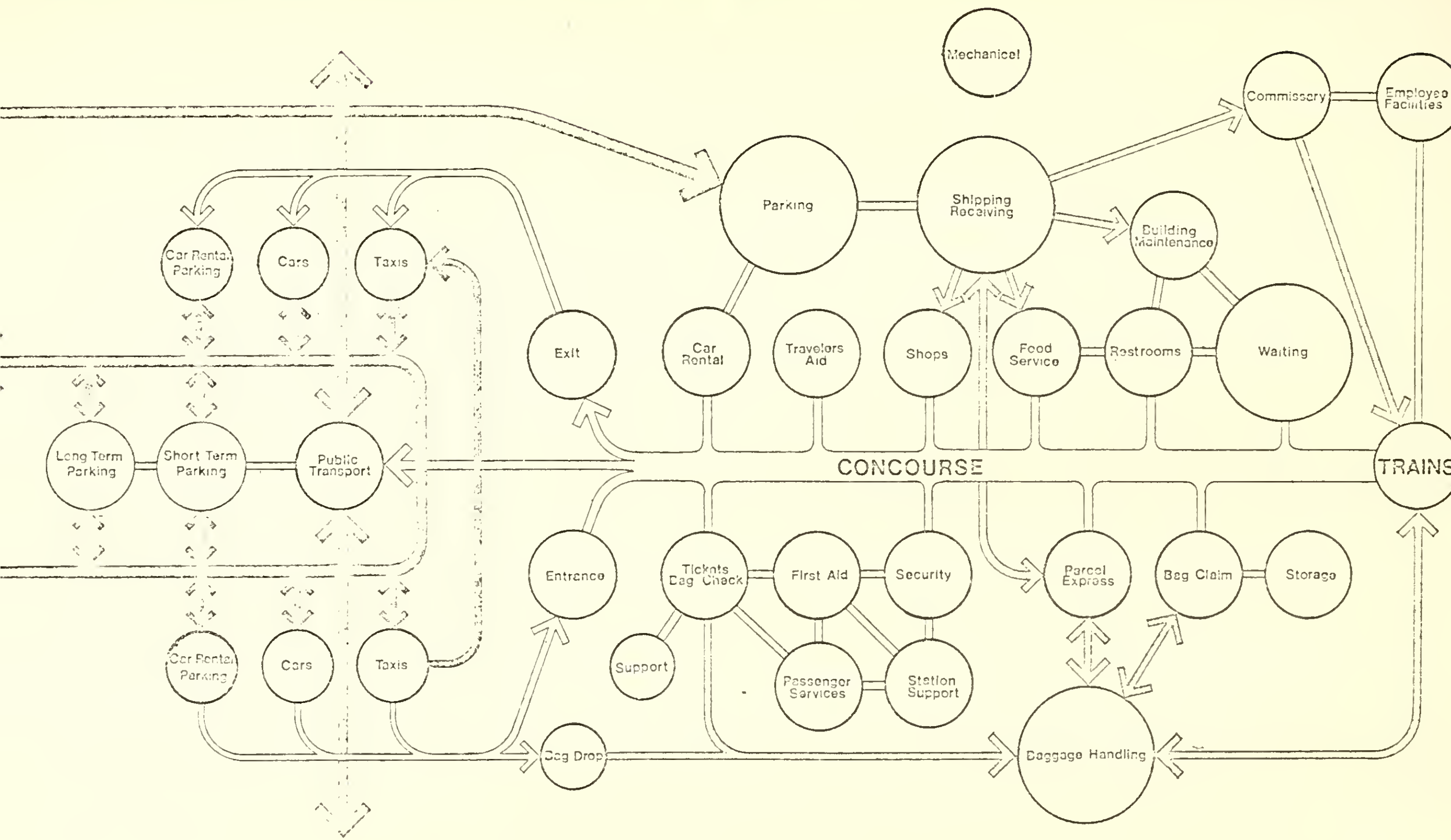


FIGURE 4-1. RAIL TERMINAL FLOW DIAGRAM

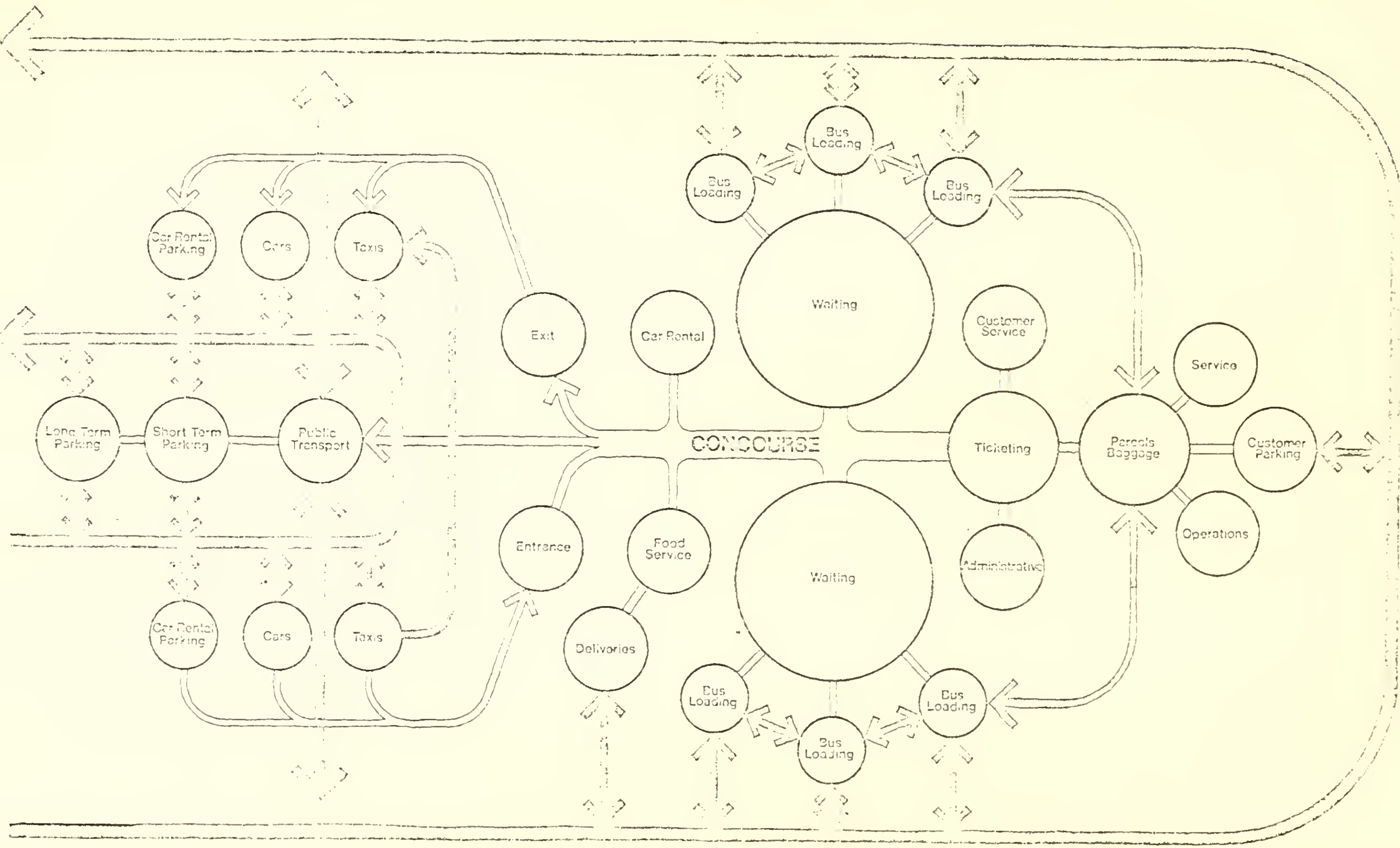


FIGURE 4-2. BUS TERMINAL FLOW DIAGRAM

## CHAPTER 5 - SPACE REQUIREMENTS

This chapter translates the various Transportation Center functions into specific space requirements, when this can be done with available information. Some of the space requirements have been supplied by the carriers, and others are based on patronage projections or have been determined by professional experience and judgement.

### Rail Terminal Space Requirements

A series of Federal Railroad Administration studies[1,2] have set forth design standards and space requirements for the various components and facilities in Northeast Corridor rail stations (called "CorridorRail" stations in these reports). Some of these space requirements are uniform for all stations of a certain activity level. These have been reviewed and are generally presented here without change. Other space requirements are based on design-day patronage or peak-hour volumes determined by the Parsons Brinckerhoff Quade & Douglas, Inc. patronage projections, summarized in Chapter 3.

Tracks and Platforms. Ten tracks will be required for commuter and intercity trains. High-level platforms are to be placed between each pair of tracks. The FRA standards require the platforms for high-speed rail service to be a minimum of 1200 feet long and 24 feet wide. Two such platforms and four tracks are required for Amtrak service. For platform access, if a change of level is necessary, the FRA requires a minimum of one elevator, two escalators and one stair per platform.

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1. DC/STV, A Joint Venture of De Leuw, Cather & Company and STV, Inc., Northeast Corridor High Speed Rail Passenger Service Improvement Project Task 7A--Terminals, for Federal Railroad Administration, May 1975.

2. Task 12 excerpts provided by the Federal Railroad Administration November 14, 1975.

Fixed Space Requirements. Fixed space requirements for "A" activity level stations (South Station is in this category) are summarized in Table 5-1. These square foot requirements for the various parts of the rail terminal were obtained from the table "Summary of Space Requirements--NSP," dated November 4, 1975.[3]

Volume-Dependent Space Requirements. Space requirements for most of the public facilities, such as ticketing, waiting area and rest rooms, are based on peak-hour passenger volumes.

The standards are described in Table 5-2. Using the patronage projections summarized in Chapter 3, these standards are then applied to produce the space requirements listed in Table 5-3.

Parking and Loading Requirements. The spaces required for rail passenger long and short-term parking, and curb spaces for autos and taxis, are summarized in Table 5-4. Long-term parking needs were determined on the basis of one space for each departing design-day park-and-ride driver, the standard used by the FRA. Short-term parking requirements and taxi and auto curb space are based on the 15-minute peak-period vehicle volumes presented in Table 3-5. In determining the short-term parking and curb space requirements, the following assumptions were used:

(1) average short-term parking time, 30 minutes,

(2) average taxi unloading and loading time, one minute,

(3) average auto unloading time, two minutes,

(4) average auto loading time, three minutes,

(5) taxi queue space sufficient for three minutes waiting time.

In calculating the linear feet of curb required, the FRA uses the standard of 50 feet for the first vehicle and 20 feet for each additional vehicle. If auto and taxi unload and load were to take place at a single curb, the 24 spaces would require 510 linear feet. The taxi queue would also require an additional 200 feet, but not necessarily at a loading curb.

## Bus Terminal

In a letter to the BRA dated April 3, 1973,[4] Greyhound summarized the space and facilities that it and its present tenant bus lines would require in the proposed Transportation Center. These requirements have been reviewed and revised as necessary, and, in addition, similar or slightly lower requirements are included for the bus lines now using the Trailways terminal.

3. Op. Cit., Task 17 excerpts.

4. Letter from J. H. Dobyns, Director--Properties, Greyhound Lines-East, to Mr. Stewart Forbes, Deputy Director of Development ... dated April 3, 1973.

Bus Platforms. Greyhound, in the April 1973 letter, stated that it and its tenants would require a minimum of 25 loading docks in the Transportation Center, and an expansion capacity for 5 additional docks. In addition, Greyhound needs 6 storage spaces to park buses along the driveway behind the loading platforms. If bus platform requirements for the lines using the Trailways terminal are calculated as 80 percent of Greyhound's, they would need 20 loading docks, capacity for 4 expansion docks, and 5 storage spaces. Total platform needs for tenants at the present terminals, then, are 45 platforms, with expansion capability for 9 or more, and 9 storage spaces along the driveway.

Sawtooth loading platforms are needed for intercity bus operations but many of the bus operations at the present terminals are commuter-type, and would operate from pull-through parallel loading platforms. In addition to platforms for the carriers using the present terminals, commuter platforms are needed for MBTA express buses.

Based on observation of present operations, and growth projections to 1990, the bus platform requirements have been determined for each carrier. These are presented in Table 5-5. Calculated in this manner, 36 sawtooth intercity docks and 30 pull-through commuter docks are required for a total of 66 docks. Standby and layover space should be provided for as many as 20 buses--10 intercity and 10 commuter. Additional space for long term bus storage may be desired by the operators but need not be a part of the Transportation Center.

Space Requirements. The square-foot requirements for the various components of the bus terminal portion of the Transportation Center are listed in Table 5-5. For Greyhound and its present tenants, the space requirements were either obtained directly from the April 1973 letter or calculated on the basis of the description of facilities in that letter.

No specific list of requirements from Trailways was available. For many facilities, Trailways and the other bus operators now using its terminal are expected to require separate facilities equal to those for Greyhound. Therefore, the Greyhound requirements in Table 5-6 are repeated for Trailways. For other facilities, based on a slightly lower level of operations, the space requirements have been calculated as 80 percent of Greyhound's requirements.

Parking and Loading Requirements. The requirements for long-term parking, short-term parking, and automobile and taxi curb space to serve the bus terminal portion of the Transportation Center are outlined in Table 5-7. Greyhound has indicated a need for 15 parking spaces, serving the package express facility, and from this it is estimated that Trailways would require 12 spaces for package express. Parking requirements and curb space for autos and taxis are based on the peak-hour and design-day patronage forecasts from Chapter 3 and the assumptions adopted for the rail terminal.

TABLE 5-1

# RAIL TERMINAL FIXED SPACE REQUIREMENTS
(Square Feet)

## Passenger Service

| | |
|---|---|
| First Aid/Medical | |
| Reception/Nurse Area | 100 |
| Doctors Desk | 80 |
| Exam Area | 100 |
| Infirmary | 20 |
| Toilet | 25 |
| Storage | 5 |
| Direct Line Phone | 5 |
| | 335 |
| Travelers Aid | |
| Graphic Information | 60 |
| Two attendents | 80 |
| | 140 |
| Security | |
| Police Desk | 205 |
| Holding Room | 70 |
| General Area | 100 |
| Toilet Room | 35 |
| Locker Area | 65 |
| Direct Line Phone | 5 |
| Circulation | 80 |
| | 560 |
| Drinking Fountains (pairs @ 12 s.f.) | |
| Waiting Area | 12 |
| Concourse | 12 |
| Circulation | 12 |
| Restroom Entries | 12 |
| Vending Area | 12 |
| | 60 |
| Passenger Service Area | |
| Passenger Services | |
| Waiting | 200 |
| Semi-priv. | 160 |
| General Office | |
| Clerical | 400 |
| Duty Sup. | 200 |
| Manager | |
| Manager | 200 |
| Sec./Recpt. | 100 |
| Storage Area | 190 |
| | 1,450 |
| Lost and Found | 120 |
| Information | 200 |

## Baggage

| | |
|---|---|
| Mail, Baggage, Express | |
| General Office | 120 |
| Collection, Handling | |
| Office | 575 |
| Area | 2,300 |
| Equipment Storage | 105 |
| | 3,100 |
| Postal Service | |
| Vending Area | 100 |
| Mail Drops | 15 |
| | 115 |
| Package Express | |
| General Area | 500 |

## Food and Shops

| | |
|---|---|
| Food Service | |
| Restaurant | 1,500 |
| Snack Bar/Coffee | 800 |
| | 2,300 |
| Beverage Service | |
| Bar/Cocktail Lounge | 750 |
| Vending Service | |
| Cigarettes | 10 |
| Cold Drinks | 10 |
| Confections | 10 |
| Hot Drinks | 10 |
| Trash | 10 |
| Drinking fountain | 10 |
| | 60 |
| Shops/Kiosks | |
| Airline Tickets | 200 |
| Bank | 600 |
| Barber | 180 |
| Beauty | 250 |
| Book | 300 |
| Camera/Film | 250 |
| Candy Sweets | 150 |
| Clothing | 600 |
| Delicatessen | 400 |
| Drug Store | 400 |
| Dry Cleaning | 350 |
| Florist | 250 |
| Gifts Sundry | 250 |
| News Kiosk | 200 |
| Liquor | 200 |
| Car Rental | 150 |
| Shoe Shine/Repair | 200 |
| Sightseeing | 50 |
| Tobacco | 180 |
| | 5,160 |

## TABLE 5-1 (Cont.)

### Food and Shops (cont.)

| | |
|---|---|
| Amusements | |
| Bowling | 3,000 |
| Pin Ball | 240 |
| Movie | 3,600 |
| Television | 500 |
| | 7,340 |

### Operational

| | |
|---|---|
| Passenger Handling Support Area | |
| General Office | 1,000 |
| Cash Accounting | |
| General | 250 |
| Cashier | 150 |
| Rail Travel/Tour | 250 |
| Security/Storage | 100 |
| | 1,750 |
| Station Support Area | |
| General Office | 300 |
| Passenger/Recpt. | 75 |
| Storage/First Aid | 20 |
| | 395 |
| Train Support Area | |
| Commissary | |
| Office Area | 400 |
| Gen. Storage | 2,000 |
| Equip. Storage | 450 |
| Rest Room | 25 |
| On-Board Personnel | |
| Check-in Office | 100 |
| Dispatchers Office | 300 |
| Rest Room | 25 |
| | 3,300 |
| Employees Facilities | |
| Lounge | 160 |
| Lunch Room | 120 |
| Lockers | 160 |
| Rest Rooms | 150 |
| Showers | 50 |
| Overnight Lodging | 300 |
| | 935 |

### Building Maintenance

| | |
|---|---|
| Custodial | |
| Basic Unit (x2) | 130 |
| Equipment Storage (x2) | 150 |
| Closet | 20 |
| | 300 |
| Shipping/Receiving | |
| Office Area | 100 |
| Load/Unload | 600 |
| Storage Area | 400 |
| | 1,100 |

### Mechanical/Electrical/Utilities

5% Net Building Area

### Circulation

25% Net Building Area (approximately)

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Source: "Summary of Space Requirements—HSR," Nov. 4, 1975, from Task 12 excerpts provided by Federal Railroad Administration, November 14, 1975.

TABLE 5-2

VOLUME-DEPENDENT RAIL TERMINAL STANDARDS

| Function | Description | Standard | Based On |
|---|---|---|---|
| Ticketing | Ticket Windows: 6' separation, 42" high, 130 sf each including office backup; Queue area 15 ft. deep = 90 sf each window | 5 for first 500; 1 for each additional 250 | Peak hour one-way, intercity rail plus 50% commuter* |
| Waiting Room | seats @ 15 sf | 20 per 100 | Intercity one-way peak hour |
| | Spaces @ 10 sf | 80 per 100 | Intercity one-way peak hour |
| | Seats @ 15 sf | 1 per 100 | Commuter one-way peak hour |
| | Spaces @ 10 sf | 25 per 200 | Commuter one-way peak hour |
| Rest Rooms | Entrance<br>Attendant/Vending | 60 sf<br>70 sf | |
| Men's Toilet | Urinal @ 21 sf | 3 for first 600; 1 per 300 additional | Peak hour one-way total |
| | Water Closet @ 21 sf | 3 for first 400; 1 per 500 additional | Peak hour one-way total |
| | Lavatory @ 21 sf | 3 for first 750; 1 per 500 additional | Peak hour one-way total |
| Women's Toilet | Water Closet @ 21 sf | 3 for first 400; 1 per 300 additional | Peak hour one-way total |
| | Lavatory @ 21 sf | 3 for first 750; 1 per 500 additional | Peak hour one-way total |
| Bag Check, Claim | Area | 10 sf each | 10% Intercity peak hour one-way |
| Telephones | Phones @ 10 sf | 3 per 200 | Peak hour one-way total |
| Lockers | @ 1.6 sf | 1 per 10 | Intercity one-way peak hour |

* Adjusted from FRA standard, which used one-way peak hour total.

TABLE 5-3

VOLUME-DEPENDENT RAIL TERMINAL SPACE REQUIREMENTS
(Square Feet)

| | |
|---|---|
| Ticketing | |
| Ticket Area | |
| 16 Windows | 2,080 |
| Queue Space | 1,440 |
| | 3,520 |
| Waiting | |
| Waiting Room | |
| 242 Seats | 3,630 |
| 1,325 standing spaces | 13,250 |
| Circulation 10% | 1,688 |
| | 18,568 |
| Passenger Service | |
| Toilets | |
| Men's (18 urinals, 13 w.c., 12 lavatories) | 1,033 |
| Women's (19 w.c., 12 lavatories) | 781 |
| | 1,814 |
| Telephones | |
| 78 phones | 780 |
| Baggage | |
| Bag Check, Claim | 1,000 |
| Lockers (100) | 160 |

TABLE 5-4

RAIL TERMINAL PARKING AND LOADING REQUIREMENTS

| Function | Spaces |
|---|---|
| Long-Term Parking | 343 |
| Short-Term Parking | 144 |
| Auto Unloading | 8 |
| Auto Loading | 9 |
| Taxi Unloading | 4 |
| Taxi Loading | 3 |
| Taxi Queuing | 10 |

TABLE 5-5

BUS PLATFORM REQUIREMENTS

| Bus Line | Present Use in Terminal* | 1990 Sawtooth | 1990 Drive Thru |
|---|---|---|---|
| MBTA | 0 | - | 5 |
| Gray Line | 1 | - | 5 |
| Wellesley | 1 | - | 1 |
| Ritchie | 0 | - | 1 |
| ABC | 1 | - | 1 |
| BosCom | 1 | - | 1 |
| Hudson | 1 | - | 1 |
| Almeida | 4 | 2 | 3 |
| Trombley | 1 | 1 | 1 |
| Bonanza | 3 | 2 | 2 |
| Englander | 1 | 1 | 1 |
| P & B | 3 | 2 | 4 |
| Greyhound | 8 | 10 | - |
| Vermont | 2 | 3 | - |
| Michaud | 1 | 1 | - |
| Trailways | 4 | 7 | - |
| Peter Pan | 2 | 3 | - |
| Misc. | - | 4 | 4 |
| | | 36 | 30 |

* Exclusively or on a shared basis. Present Greyhound Terminal has 18 platforms, Trailways Terminal 10.

TABLE 5-6

BUS TERMINAL SPACE REQUIREMENTS
(Square Feet)

| | Greyhound and Tenants | Trailways and Tenants | Total |
|---|---|---|---|
| Ticketing/Bag Check | | | |
| Ticket Center (8 selling positions with 4 bag pass-through gates, 40' long 7'6" deep) | 300 | 300 | 600 |
| Queue Space | 600 | 600 | 1,200 |
| Bag Claim Center (6' long) | 50 | 50 | 100 |
| Queue Space | 90 | 90 | 180 |
| Ticket Agents Cash/Check Out | 150 | 150 | 300 |
| | | | 2,380 |
| Waiting | | | |
| Waiting Room | 7,000 | 5,600 | 12,600 |
| Circulation | 1,400 | 1,120 | 2,520 |
| | | | 15,120 |
| Passenger Service | | | |
| Customer Service Office | 250 | 250 | 500 |
| Men's Rest Room (6 wc, 6 ur 6 lav) | 510 | 510 | 1,020 |
| Women's Rest Room (6 seat lounge, 10' counter, 10 wc 10 lav) | 520 | 520 | 1,040 |
| Travel Bureau | 500 | 500 | 1,000 |
| | | | 3,560 |
| Baggage | | | |
| Baggage/Package Express Room | 6,000 | 4,800 | 10,800 |
| Baggage Office (3 desks, 6 files) | 200 | 200 | 400 |
| Lost & Found/Lockers/Baggage Storage, Etc. | 500 | 400 | 900 |
| Terminal Supply Storage | 225 | 180 | 405 |
| | | | 12,505 |
| Food and Shops | | | |
| Restaurant and Shops | 10,000 | 8,000 | 18,000 |
| Operational | | | |
| Terminal Managers Office | 150 | 150 | 300 |
| Administration Offices | 1,250 | 1,000 | 2,250 |
| Telephone Information Room (14 carrells, 28'x 20') | 560 | 560 | 1,120 |
| Telephone Equipment Room | 100 | 100 | 200 |
| Operations Office | 150 | 150 | 300 |
| Drivers Check-In | 150 | 150 | 300 |
| Drivers Lounge & Toilet | 240 | 240 | 480 |
| | | | 4,950 |

TABLE 5-7

BUS TERMINAL PARKING AND LOADING REQUIREMENT

| Function | Spaces |
|---|---|
| Package Express | 27 |
| Long-Term Parking | 170 |
| Short-Term Parking | 100 |
| Auto Unloading | 5 |
| Auto Loading | 6 |
| Taxi Unloading | 3 |
| Taxi Loading | 2 |
| Taxi Queuing | 7 |

Using the FRA standard of 50 feet for the first vehicle and 20 feet for each additional vehicle, the bus terminal would require 350 feet for auto and taxi unloading and loading functions. The taxi loading would require another 140 feet for taxi queuing. For more efficient taxi operations it would be desirable to combine the taxi loading space for the bus terminal and the rail terminal.

## Space Requirements Summary

The space requirements for the rail terminal portion of the Transportation Center, from Table 5-1 and Table 5-3, and for the bus terminal, from Table 5-6, are summarized in Table 5-8, according to the major functional areas.

## Other Space Requirements

In addition to the facilities described above in the rail and bus terminals, the Transportation Center must also provide space for a number of other transportation and related functions. Precise space requirements for each of these functions require consultation with prospective concessionaires and further development of a design concept, and therefore, cannot be determined at this time. However, certain requirements can be described subjectively here.

Car Rental Parking. An area should be provided in the Transportation Center where car rental customers can pick up and drop off their rental cars. Space on one of the parking levels could be set aside for this use after the space requirements are determined. The car rental servicing and garage facilities probably would not be located in the Transportation Center.

Airline Terminal. Space for airline ticketing--possibly with satellite check-in service--should be provided in the Transportation Center, preferably in an area somewhat removed from that devoted principally to bus or train terminal use. Nearby curb space is needed for loading of airline limosines or buses. The amount of curb space cannot be determined at this time, but the FRA requirements specify 140 linear feet for the first bus and 40 feet for each additional bus.

Restaurants and Shops. The terminal should also include space for restaurants, shops, and other commercial space to serve Transportation Center users, as well as the general public. These kinds of facilities could be developed in addition to the restaurants and shops necessary for the travelling public.

Building Maintenance. In addition to the specific space requirements for building maintenance set forth for the rail terminal, space for this function for the entire Transportation Center should be provided. A shipping/receiving area is needed to handle maintenance supplies and supplies for the concessionaires and restaurants throughout the Center.

TABLE 5-8

TRANSPORTATION CENTER SPACE SUMMARY

| Functional Area | Rail Terminal | Bus Terminal |
|---|---|---|
| Ticketing | 3,520 | 2,380 |
| Waiting | 18,568 | 15,120 |
| Passenger Service | 5,459 | 3,560 |
| Baggage | 4,875 | 12,505 |
| Food and Shops | 15,610 | 18,000 |
| Operational | 6,380 | 4,950 |
| Maintenance, Storage | 1,400 | NA |

APPENDIX

Technical Memorandum #1

FUTURE INTERCITY RAIL PATRONAGE

Demand for future intercity rail passenger service was developed by Bechtel, Inc. for the Federal Railroad Administration. The process and results are documented in Northeast Corridor High Speed Rail Passenger Service Improvement Project, Task I - Demand Analysis, April, 1975. The following discussion reviews the FRA forecast methodology and suggests appropriate adjustments in its application to estimating future intercity rail patronage at Boston's South Station. "Corridor Rail" and "intercity rail" are synonymous when used in reference to patronage at South Station.

Assumptions

Task 1 forecasts are based on the following assumptions (pp 3-2, 3,4). Except where noted, these assumptions are considered to be valid.

1. Premium and coach service will be provided.

2. Premium fares will be comparable to current real Metroliner and air fares. Coach fares will be comparable to bus fares.

3. Task 1 assumed 5-stop, 3-hour service between Boston and New York and 5-stop, 2-1/2 hour service between New York and Washington. Recent statements by Secretary of Transportation Coleman indicate that 3-1/2 - 4-hour service between Boston and New York is achievable in the foreseeable future.

4. Task 1 assummed that South Station and Route 128 Station would be the only stations served in the Boston area. Consideration should be given to a stop at Back Bay Station as well.

5. South Station will be served by two trains per hour in each direction from 6 AM to 10 PM.

6. The entire northeast corridor rail system will be designed to accomodate all demands through at least 1990.

Methodology - Estimate for 1990 Corridor Rail Potential

Taking into consideration the previously described assumptions, the steps taken to estimate 1990 high and low potential person trips for Corridor Rail were as follows:

1. Estimate 1973 volumes of intercity trips, by mode of travel, for traffic which could be diverted to Corridor Rail.

2. Estimate 1990 volumes of intercity trips, by mode of travel, for traffic which could be diverted to Corridor Rail. This step comprises estimates of growth, 1973 to 1990, for both a high and a low 1990 potential body of traffic.

3. Estimate amounts of 1990 traffic which may be diverted from air, bus and private automobile modes to Corridor Rail, for both high and low 1990 potentials.

4. Estimate, for both high and low 1990 potentials, the amount of new induced traffic that may be generated by the introduction of the improved high speed rail service to be provided by Corridor Rail.

Step 1

Task 1 estimates 1973 person trips between Boston and other northeast corridor cities as follows:

| | | 1973 Person Trips |
|---|---|---|
| Boston - | Providence | 9,053,000 |
| | New London | 668,000 |
| | New Haven | 725,000 |
| | Bridgeport/Stamford | 476,000 |
| | New York | 5,852,000 |
| | Trenton | 94,000 |
| | Philadelphia | 1,064,000 |
| | Wilmington | 119,000 |
| | Baltimore | 289,000 |
| | Washington | 1,144,000 |
| | TOTAL | 19,484,000 |

Step 2

Task 1 develops growth multipliers which when applied to 1973 intercity patronage yield estimated 1990 patronage. The multipliers - a low potential and a high potential - reflect population growth and per capita disposable income growth for the northeast corridor.

| | (Composite) Growth Multiplier | Income Factor | Population Factor |
|---|---|---|---|
| Low Potential | 1.45 | 1.25 | 1.16 |
| High Potential | 1.77 | 1.44 | 1.23 |

Comparable population growth rate estimates (1973-1990) for the NEPR region range from 1.08 to 1.14. The higher estimate was prepared as part of Task A of the transportation planning review process in 1970. The lower estimate was developed for the [illegible] in 1974 and reflects recent birth rates in the region. Both of these estimated growth rates are lower than the Low Potential rate used in Task 1 and probably are more reasonable.

The disposable income factors appear reasonable and in this anaylsis will be used as given.

In planning for the South Station Transportation Center the range of Growth Multiplier and estimates of total 1990 inter-city person trips to or from Boston should be revised as follows:

| | 1990/1973 Growth Multiplier | Intercity Person Trips To/From Boston |
|---|---|---|
| Low Potential | 1.35 | 26,303,000 |
| High Potential | 1.77 | 31,487,000 |
| Most Likely | 1.40 | 27,278,000 |

Step 3

Task 1 developed modal split relationships as functions of rail/air and rail/bus travel time ratios. Using the assumed rail travel times between Boston and other points along the corridor and representative station access times, modal splits were estimated for each city pair. Potential diversions from private auto were estimated through a systematic though subjective analysis of the effects of trip length, travel group size, the proximity of trip ends to railroad stations, travel times, and costs.

These modal split estimates should be revised to reflect attainable near term inter-city travel times of 4 hours Boston to New York and 3 hours New York to Washington. Ultimately the travel times assumed in Task 1 may be attainable, but not by 1990. The following table presents revised percentages of total person trips assigned to the rail mode in 1990.

Estimated Rail Share of Total 1990 Person Trips

| Boston to | Task 1 Low | Task 1 High | Revised Low | Revised High | Revised Probable |
|---|---|---|---|---|---|
| Providence | 4.6% | 6.6% | 2.0% | 4.0% | 3.0% |
| New London | 16.5 | 26.1 | 13.4 | 23.2 | 18.3 |
| New Haven | 22.8 | 31.2 | 15.0 | 23.3 | 19.1 |
| Bridgeport | 20.5 | 29.2 | 16.3 | 25.1 | 20.7 |
| New York | 22.0 | 29.2 | 14.9 | 21.4 | 18.1 |
| Trenton | 19.7 | 28.1 | 17.7 | 26.5 | 22.1 |
| Philadelphia | 12.7 | 18.7 | 7.7 | 12.7 | 10.2 |
| Wilmington | 15.6 | 24.4 | 13.3 | 22.4 | 17.8 |
| Baltimore | 11.6 | 15.4 | 10.2 | 13.8 | 12.0 |
| Washington | 11.1 | 14.4 | 9.7 | 13.7 | 11.7 |

Step 4

Task 1 based its estimates of induced rail traffic on a review of data describing patronage on the New Jersey Turnpike and the Garden State Parkway. While this procedure does not provide a strong basis for estimating induced volumes, it is probably conservatibe in producing high estimates. The percentages of induced traffic utilized in this analysis are the same as those in Task 1.

| | Induced Rail Travel Multiplier Low Potential | Induced Rail Travel Multiplier High Potential |
|---|---|---|
| New York to Boston segment | 1.07 | 1.15 |
| Through New York Trips | 1.10 | 1.25 |

Summary of Annual Intercity Rail Person Trips

Annual intercity rail trips between downtown Boston and other northeast corridor cities are computed as products of 1973 total person trips, 1990/1973 travel growth multipliers, rail mode share of total trips, and induced rail travel multipliers. A comparison of the annual 1990 intercity rail trips to or from Boston is presented in Task 1 and as revised herein is presented below.

1990 Rail Person Trips (000's)

| Between Boston and | Task 1 | | Revised | | |
|---|---|---|---|---|---|
| | High | Low | High | Low | Probable |
| Providence | 1216 | 646 | 737 | 262 | 407 |
| New London | 355 | 171 | 315 | 129 | 183 |
| New Haven | 460 | 256 | 344 | 157 | 207 |
| Bridgeport | 283 | 151 | 243 | 112 | 148 |
| New York | 3478 | 2079 | 2549 | 1260 | 1587 |
| Trenton | 58 | 30 | 48 | 25 | 32 |
| Philadelphia | 440 | 216 | 299 | 122 | 167 |
| Wilmington | 64 | 30 | 59 | 24 | 33 |
| Baltimore | 98 | 53 | 88 | 44 | 53 |
| Washington | 364 | 203 | 347 | 165 | 206 |
| TOTAL | 6816 | 3835 | 5029 | 2300 | 3023 |

The revised estimate of 3,023,000 rail person trips expected for 1990 compares to an estimate of 4,568,000 rail person trips forecast for 1990 in the Task 1 report and in a more recent FRA memorandum. The remainder of this analysis is based on the revised probable ridership estimate.

Effect of Route 128 and Back Bay Stations

FRA Task 1 (Table 3.17) estimates that 15% of the intercity rail patronage in the Boston region will utilize Route 128 Station.

It is estimated by CTPS that 2/3 of the rail passengers (commuter and intercity) to downtown Boston arrive at South Station and that 1/3 arrive at Back Bay Station. It is likely that MBTA commuter trains will continue to make two stops in downtown Boston. If Back Bay Station is retained as an AMTRAK stop, intercity rail patronage at South Station probably will be reduced by a minimum of 20% from the foregoing estimates. This assumes that some of the current riders at Back Bay Station will be attracted to South Station by the planned parking and new facilities.

For the purposes of planning the Transportation Center, it is assumed that intercity rail service at Back Bay Station will be discontinued and that South Station patronage will be 85% of total intercity rail patronage in the Boston region.

Daily and Hourly Variations in Demand

Task 1 describes the daily variations in intercity rail ridership for 1972 on the Boston-to-New York and New York-to-Washington segments. It suggests that rail service be designed to meet demand 95% of the time. Recognizing that train schedules will vary with the day of the week, the service level for Fridays will be designed to accommodate 0.33% of future annual patronage. In 1972, the 9th highest day in the New York-to-Washington segment represented 0.38% of that year's ridership.

Task 1 suggests that with the anticipated patronage increases in the Boston-to-New York segment, daily variations will approach the current patterns in the New York-to-Washington segment. However, in planning for facilities at South Station it is likely that the design volume should be more than 0.35% of the annual traffic for the following reasons:

1. fluctuations in demand for specific facilities will be greater than for the corridor as a whole, because of the peak averaging effects of combining patronage from several communities;

2. percentage deviations from average days are greater for smaller numbers than for larger numbers;

3. on days with very larger demand, more of that demand will be satisfied at terminal stations than at line stations as a result of the fact that first-come are first-served.

It is recommended that for planning the South Station complex, the design day patronage be established as 0.50% of annual 1990 patronage. In 1973, this represented the 10th highest day on the Boston-to-New York segment.

Hourly variations for arrivals and departures at South Station are estimated from information presented in Task 1. By weighting the hourly distribution of arrivals and departures on a typical Friday by the "probable" 1990 rail person trips between specific city pairs (presented above) a composite hourly distribution of rail passengers has been derived for South Station and is presented in the table on the following page. That table indicates that on a peak Friday, 11% of the day's arrivals and 15% of the day's departures occur in the 5-6 P.M. period. Travel on a peak Monday would be distributed differently, with greater concentrations of departures during the morning rush hour and arrivals during late morning. It is unlikely that the maximum arrivals and maximum departures will occur simultaneously.

Patronage during peak 30-minute interval can be estimated as 65% of the peak hour patronage.*

* From table entitled CORRIDORRAIL STATIONS, HSR PATRONAGE dated 10/7/75 and revised 10/29/75. Peaking factors attributed to Peat, Marwick, Mitchell and Company and Barton-Aschman Associates, Inc.

ARRIVALS & DEPARTURES AT
SOUTH STATION ON A PEAK FRIDAY, BY HOUR

| | Arrivals | | | | Departures | | | | Arrivals & Departures | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | High | Low | Probable | % | High | Low | Probable | % | High | Low | Probable |
| nual Person Trips (000) | | 2,137 | 978 | 1,285 | | 2,137 | 978 | 1,285 | | 4,274 | 1,956 | 2,570 |
| sign Day Trips | .5* | 10,685 | 4,890 | 6,425 | .5* | 10,685 | 4,890 | 6,425 | .5* | 21,370 | 9,780 | 12,850 |
| urly Design Day Trips ur Beginning | | | | | | | | | | | | |
| Midnight | 3** | 321 | 147 | 193 | | | | | 1.5** | 321 | 147 | 193 |
| | | | | | 2** | 214 | 98 | 129 | 1 | 214 | 98 | 129 |
| | | | | | 3 | 321 | 147 | 193 | 1.5 | 321 | 147 | 193 |
| | 2 | 214 | 98 | 129 | 4 | 427 | 196 | 257 | 3 | 641 | 294 | 386 |
| | 7 | 748 | 342 | 450 | 7 | 748 | 342 | 450 | 7 | 1,496 | 684 | 900 |
| | 5 | 534 | 244 | 321 | 3 | 321 | 147 | 193 | 4 | 855 | 391 | 514 |
| | 5 | 534 | 244 | 321 | 4 | 427 | 196 | 257 | 4.5 | 961 | 440 | 578 |
| | 5 | 534 | 244 | 321 | 4 | 427 | 196 | 257 | 4.5 | 961 | 440 | 578 |
| Noon | 5 | 534 | 244 | 321 | 8 | 855 | 391 | 514 | 6.5 | 1,389 | 635 | 835 |
| | 3 | 321 | 147 | 193 | 5 | 534 | 244 | 321 | 4 | 855 | 391 | 514 |
| | 4 | 427 | 196 | 257 | 7 | 748 | 342 | 450 | 5.5 | 1,175 | 538 | 707 |
| | 4 | 427 | 196 | 257 | 9 | 962 | 440 | 578 | 6.5 | 1,391 | 636 | 835 |
| | 11 | 1,175 | 538 | 707 | 11 | 1,175 | 538 | 707 | 11 | 2,350 | 1,076 | 1,414 |
| | 11 | 1,175 | 538 | 707 | 15 | 1,603 | 734 | 964 | 13 | 2,778 | 1,272 | 1,671 |
| | 5 | 534 | 244 | 321 | 7 | 748 | 342 | 450 | 6 | 1,282 | 586 | 771 |
| | 12 | 1,282 | 587 | 771 | 6 | 641 | 293 | 386 | 9 | 1,923 | 880 | 1,157 |
| | 4 | 427 | 196 | 257 | 2 | 214 | 98 | 129 | 3 | 641 | 294 | 386 |
| | 12 | 1,282 | 587 | 771 | | | | | 6 | 1,282 | 587 | 771 |
| | 2 | 214 | 98 | 129 | 3 | 321 | 147 | 193 | 2.5 | 535 | 245 | 322 |

* % of Annual Total
** % of Day's Total

Based on the preceding estimates and assumptions, the recommended 1990 design passenger volumes for the intercity rail facility at South Station are as follows:

| Peak Period | | 1990 Design Passenger Volumes Arrivals | Departures | Arrivals Departur |
|---|---|---|---|---|
| 8-9 A.M., | 60 minutes | 700 | 700 | 1400 |
| | 30 minutes | 450 | 450 | 900 |
| 5-6 P.M., | 60 minutes | 700 | 1000 | 1700 |
| | 30 minutes | 450 | 650 | 1100 |
| Maximum, | 60 minutes | 1000 | 1000 | -- |
| | 30 minutes | 650 | 650 | -- |

Mode of Access to South Station

Task 7A* presents 1990 modal splits assumed for each terminal in the northeast corridor. They were based on professional judgement experience, and available information. The authors of Task 7A suggest that "it would be desirable to undertake a modal split study of present arrivals at each terminal" rather than to rely on their estimates in formulating major decisions.

Modal split percentages suggested for use in design of the transportation center are based on observations of existing intercity terminals in Boston with the constraint that they generally confo to the limits suggested by the FRA report.

| | Modal Split Percentage FRA High | Task 7a Low | Median | Recommended |
|---|---|---|---|---|
| Park and Ride | 10 | 3 | 8 | 5 |
| Auto Passenger | 5 | 1 | 4 | 3 |
| Kiss and Ride | 10 | 5 | 8 | 20 |
| Subway | 40 | 30 | 40 | 35 |
| Bus | 20 | 10 | 20 | 5 |
| Taxi, Limosine | 15 | 5 | 10 | 10 |
| Walk | 15 | 5 | 10 | 10 |
| Intra-terminal | -- | -- | -- | 12 |

* DC/STV, Inc. (DeLeuw, Cather and Company and STV), Northeast Corridor High Speed Rail Passenger Service Improvement Project, Task 7A-Terminals, for the Federal Railway Administration, May 1975

Intercity Rail Schedule and Train Consists

Task 7A (p. 19-20) indicates that "Amtrak has specified that it will require four 1200-foot-long tracks (two platforms) for intercity service," and that two trains per hour will be scheduled in each direction along the corridor. These requirements are consistent with the ridership forecasts developed in Task 1 for the Boston-New York segment of the Northeast Corridor and the standard policy of establishing train consists to accommodate mean Friday ridership. They also are consistent with the lower Revised, Probable ridership at South Station estimated in this report, if AMTRAK adopts a policy to accommodate peak hour ridership on the 10th highest day of the year.

Technical Memorandum #2

# FUTURE INTERCITY AND COMMUTER BUS PATRONAGE

This memorandum looks at patronage on the bus lines and routes that are considered likely to use a consolidated Transportation Center at South Station. All of the privately owned bus lines that presently use the Greyhound and Trailways bus terminals in the Park Square area, as well as the four Turnpike Express routes operated by the MBTA that serve the downtown area near South Station are considered. Local MBTA bus routes in the South Station area, which provide downtown distribution and serve South Boston are not considered in this analysis.

## Type of Service

In order to project future bus patronage, it is necessary to classify the bus operations likely to use the Transportation Center as to the type of service they provide. The basic classifications are commuter and intercity. This distinction is necessary because patronage projections are calculated differently for the various types of service and because the Transportation Center will have separate bus facilities for serving intercity and commuter buses and passengers.

Commuter buses carry people between a central core city and its surrounding suburban area. Commuters generally ride the same bus route each day, and their ultimate destination is usually close to the point of disembarkation. Some of the characteristics of commuter bus operations are: (a) shorter routes than intercity operations, usually between a large city and its surrounding suburbs or satellite cities; (b) more frequent service provided inbound during the morning peak hours and outbound during the afternoon peak; (c) more buses scheduled on weekdays than on weekends; (d) different types of equipment, commuter buses resembling local city buses rather than intercity buses.

The bus lines likely to use the South Station Transportation Center are placed in four classifications: MBTA commuter lines, privately-owned commuter lines, mixed commuter/intercity lines, and privately-owned intercity bus lines. Table 1 assigns the bus lines to these categories.

In this analysis MBTA buses are kept separate from the others. Operated by a public agency, their mode of operation differs somewhat from the other bus lines. MBTA Turnpike express bus routes that serve the South Station area are #300 from Riverside, #301 from Brighton Center, #304 from Watertown Square, and #305 from Waltham. The equipment used on these routes is similar to MBTA city buses. Fare is collected on board.

The bus lines classed as "private commuter" serve the Greyhound or Trailways terminals from cities and towns around Boston. Wellesley Fells makes a number of stops along Route 9 between Boston and Framingham. ABC has a similar service along Route 1 between Boston and Providence, and Ritchie along Route 20 between Boston and Northboro. Boston Commuter lines serves Haverhill and Lawrence, and Hudson serves Peabody, with mostly peak hour operations. Gray Line has some characteristics of intercity bus lines (package express service is offered and intercity type coaches are used) but has a heavy peak period patronage and would be likely to use commuter platforms in the Transportation Center. During peak periods Gray Line buses are dispatched on a "load-up-and-go" basis.

Several bus lines exhibit some of the characteristics of both commuter and intercity operations, and are placed in the "mixed" category. All use intercity type coaches and offer express package service. In the Transportation Center, these lines might use commuter platforms during peak hours, but also might operate some departures from saw-tooth intercity platforms. Plymouth & Brockton (whose schedule incorporates Brush Hill service) is oriented toward commuter service. It has more than half of its arrivals scheduled between 7 and 9 a.m. and serves some of the South Shore suburbs fairly close to Boston. Plymouth & Brockton also provides service to Hyannis on the Cape, with a good deal of resort traffic, and would be likely to operate some service from the intercity terminal. Almeida also serves Cape Cod but also has commuter-oriented service to Middleboro and New Bedford. Bonanza serves Providence, Newport, and Fall River, and its schedule indicates that some of the buses are scheduled to serve commuters as well as inter-city travelers. Likewise, Englander provides service to Fitchburg and points west, and Trombley to Lawrence and Andover, both providing service throughout the day but with a somewhat heavier schedule during the commuter peak periods.

The other bus lines, Greyhound, Vermont Transit, Michaud, Trailways, and Peter Pan are classed as intercity carriers. Except for Peter Pan, all provide interstate service only. None of these lines serve places considered to be within normal commuting distance.

TABLE 1

CURRENT BUS ARRIVALS AND DEPARTURES
(From Schedules)

| | DAILY | | PEAK (7-9) | PEAK (4-6) |
|---|---|---|---|---|
| | Arr. | Dep. | Arr. | Dep. |
| MBTA 2/6/75 | | | | |
| 300 | 43 | 43 | 20 | 19 |
| 301 | 31 | 31 | 15 | 16 |
| 303 | 79 | 79 | 28 | 21 |
| 305 | 22 | 22 | 5 | 7 |
| | 175 | 175 | 68 | 63 |
| Private Commuter | | | | |
| Gray Line 10/10/75 | 57 | 53 | 21 | 19 |
| Wellesley Wells 3/9/71 | 13 | 15 | 5 | 4 |
| Ritchie 3/4/74 | 5 | 5 | 3 | 3 |
| ABC 12/11/75 | 10 | 11 | 3 | 2 |
| Boston Commuter 9/27/74 | 10 | 11 | 6 | 7 |
| Hudson 7/24/75 | 4 | 3 | 4 | 3 |
| | 99 | 98 | 42 | 38 |
| Mixed | | | | |
| Almeida 9/15/75 | 33 | 33 | 12 | 10 |
| Trombly 4/21/74 | 15 | 15 | 4 | 4 |
| Bonanza 10/2?/75 | 34 | 31 | 7 | 7 |
| Englander [illegible] | 12 | 11 | 2 | 2 |
| Plymouth & Brockton 9/6/75 | 85 | 87 | 46 | 45 |
| | 179 | [illegible] | 71 | 68 |
| Intercity | | | | |
| Greyhound 10/26/7? | 37 | 37 | 1 | [illegible] |
| Vermont 1?/2?/75 | 19 | 19 | 0 | 3 |
| Michaud 6/1?/74 | 2 | 2 | 0 | 0 |
| Trailways 10/?/?? | 2? | 27 | 3 | 5 |
| Peter Pan ?/?/7? | 21 | 21 | [illegible] | 5 |
| | 10? | 10? | [illegible] | 19 |
| | 561 | [illegible] | [illegible] | [illegible] |

Present Volumes

Table 1 shows the current numbers of daily and peak-period bus arrivals and departures for each of these bus lines, as obtained from published schedules. The peak period for commuter service is defined as 7-9 a.m. for arrivals in Boston and 4-6 p.m. for departures from Boston. Current operating schedules show a total of about 560 bus arrivals and a similar number of departures on a normal weekday. Commuter operators generally reduce schedules on weekends. Intercity bus lines, on the other hand, sometimes add buses on weekends, especially Friday and Sunday, when intercity bus traffic peaks. In addition to the scheduled movements shown on Table 1, the intercity and mixed bus lines schedule 13 additional arrivals and 14 departures for Friday only. Beyond these additional scheduled buses, the intercity operators generally add extra sections to their scheduled departures, as needed, to accommodated peak period vacation and holiday traffic.

Daily bus ridership estimates (for 1975) are shown in Table 2 for each type of service. Private commuter, mixed, and intercity ridership estimates were made from 1972 Boston Cordon Count data. Raw data were available for some bus lines showing the number of people on each arrival and departure. For other lines, data showed the number of arriving and departing passengers only for each six-hour period. An hourly distribution was made, either to correspond with the distribution of scheduled buses, or to correspond with the hourly distribution of intercity rail traffic. For other lines, no data was available, and patronage was distributed so that the total number of riders would match the total non-MBTA bus ridership for each hour, as shown in Tables 3 and 4 of the published 1972 Cordon Count for downtown Boston. Some non-MBTA bus routes which do not serve the Greyhound or Trailways terminals have not been removed from the data in Table 2, but these are few and do not significantly affect the analysis. To update these ridership counts to reflect current estimates, all ridership categories were multiplied by a factor of the increase shown by the 1974 Cordon Counts over 1972. In 1974, the year of the "gas crisis" there was a sharp growth in use of public transportation. For 1975, little or no additional growth has been apparent. (Cordon count dates for 1972 were June 19, 20 and 21; for 1974, June 24, 25, and 26.)

For the four MBTA express routes, MBTA data was made available giving peak period ridership for February 6, 1975 (generally 7-9 a.m. inbound and 4-6 p.m. outbound). Off-peak ridership was estimated by assuming an average of 20 passengers per scheduled bus.

TABLE 2

COMMUTER AND INTERCITY PASSENGERS, 1975

| | Type of Service | | | |
|---|---|---|---|---|
| Arrivals | MBTA | Private Commuter | Mixed | Intercity |
| Peak Period (7-9 A.M.) | 3,139 | 1,570 | 2,204 | |
| Off Peak | 1,360 | 1,353 | 1,660 | |
| Daily | 4,499 | 2,923 | 3,864 | 2,639 |
| Departures | | | | |
| Peak Period (4-6 P.M.) | 3,149 | 1,455 | 1,959 | |
| Off Peak | 1,260 | 1,681 | 2,148 | |
| Daily | 4,409 | 3,136 | 4,107 | 2,7[illegible] |

Daily ridership estimates from these four categories of buses were then apportioned between commuter and intercity passengers, to determine the numbers of people who might be likely to use the different facilities in the new terminal. Commuters here include all MBTA express bus and private commuter bus riders, as well as all peak-period (7-9 a.m. inbound, 4-6 p.m. outbound) passengers on mixed lines and half of the off-peak passengers on mixed lines. Intercity passengers include the remaining half of the off-peak riders on mixed lines and all riders on the intercity lines. Since the cordon counts were obtained over a three-day period, inbound and outbound ridership data were different.

The following table presents estimates of 1975 daily commuter and intercity passenger and bus movements, combining arrivals and departures.

TABLE 3

1975 DAILY COMMUTER AND INTERCITY VOLUMES
ARRIVALS & DEPARTURES

| | COMMUTER | | | | INTERCITY | | |
|---|---|---|---|---|---|---|---|
| | MBTA | Private | Mixed | Total | Mixed | Inter-city | Total |
| Passengers | 8,908 | 6,060 | 6,066 | 21,034 | 1,904 | 5,438 | 7,342 |
| Buses | 350 | 196 | 250 | 796 | 110 | 214 | 324 |

In order to project 1990 intercity bus patronage, an estimate of annual intercity patronage will be needed. Intercity traffic varies considerably by day of the week and by season of the year. The cordon counts, on which estimates of daily intercity patronage are based, were obtained on a Monday, Tuesday and Wednesday in later June. Late June is the start of the summer travel season, but travel during the Monday through Wednesday period is below the weekend peaks. The cordon count based patronage then should be close to the arithmetical average for daily traffic throughout the year. As a check, reference is made to data on intercity rail traffic from Boston, which should show a distribution pattern similar to that for intercity bus traffic. A late June weekday is assumed to be about the 150 th busiest day of the year, coming after 100 busier weekend days and 50 busier holiday and summertime travel days. From Figure 3.3 of the [illegible] Report, the 100th busiest day for intercity rail traffic would see 0.33 percent, and the 200th busiest day 0.23 percent, of annual traffic. The median of these values, 0.28 percent is very close to (1.02 times) the

daily average. Therefore, the daily volumes will be multiplied by 365 in order to estimate yearly intercity bus patronage.

This process yields an annual bus passenger volume (arrivals plus departures) of 2,286,000 for 1972 and 2,680,000 for 1974. Taking the mean of these to get 1973 patronage gives an estimate of 2,483,000 intercity bus passenger movements in Boston. In FRA Task 1 (Table 3.2) it is estimated that 734,000 of these intercity bus passenger movements were between Boston and other cities along the Northeast Corridor Rail route. The remaining 1,749,000 trips were between Boston and "non-corridor" locations.

Commuter Bus Projections

Commuter bus patronage is estimated for the year 1990. Future commuter bus ridership will depend on several factors, among them: (a) changes in regional populations, (b) changes in downtown employment, and (c) changes in commuting habits. In the following paragraphs the effects of each of these factors are evaluated separately and then combined.

Population. A number of population projections made for the Boston region in recent years were compared. For projecting commuter bus ridership, changes in population in the areas served by the buses are more important than overall changes in the regional population. The most important commuter bus market areas in the BTPR region are the Southeast Sector and the West Sector. Population projections for these sectors for 1990 range from 840,300 down to 806,500. The higher projection, made in 1970 as part of Task A of the transportation planning review process, is a result of a 19.7 percent growth over estimated 1975 population. The lower projection, developed for the BRA in 1974, is a growth of 14.9 percent over 1975. The BRA projection is based on later population data and reflects more current birth rates and migration patterns.

Employment. The South Station Urban Renewal Area Environmental Impact Report gives several estimates of employment increases for 1980 in the downtown area. When projected on a straight-line basis to 1990, these increases range from a low of five percent (CBD forecast for total employment) to a high of about 50 percent (BRA forecast for office workers). A fifty percent increase does not appear reasonable, but the dispersion of employment to the suburbs has slowed down and an increase in downtown employment greater than the low estimate seems likely by 19[illegible].

The factors for employment and population growth are combined to produce an overall employment-population multiplier. Since the population and employment factors represent changes in potential commuter trip origins and destinations, the combined factor would lie somewhere between the two. At its lowest, the combined factor would reflect the lower of either population or employment growth; at its highest, it would equal the higher of either employment or population growth. The most likely combined multiplier would be some average of the population and employment factors.

| | Population - Employment Multiplier 1975-1990 | | |
|---|---|---|---|
| | Low Potential | High Potential | Likely |
| Population Factor | 1.15 | 1.20 | 1.15 |
| Employment Factor | 1.05 | 1.50 | 1.15 |
| Combined Population-Employment Multiplier | 1.05 | 1.50 | 1.15 |

Shifts in downtown employment location could also affect the number of bus commuters. The South Station Environmental Impact Report estimates that upon completion of the urban renewal project, employment in the immediate vicinity of South Station will be 27,200, an increase of 19,150 over 1975 employment. The convenience of the location will attract some of these employees to commuter buses.

The Boston Cordon Count shows that during peak hours, approximately 50 percent of the commuters arrive in downtown Boston in private automobiles. Without any detailed information on mode shift due to employment location, it is estimated that up to 20 percent of these automobile riders would be able to use commuter buses to get to work and would do so because fo the locational convenience. This is 10 percent of the new employees in the vicinity, or about 1,900 people, who would use commuter buses, in addition to those throughout the downtown area who would choose that mode because of general employment and population increases. This figure can be added directly to the 1990 design day commuter bus projections.

Commuting Habits. A final factor that must be considered is the possible change in commuting habits and a shift towards public transportation as a result of energy shortages and public policy decisions. Public policy seems to have been firmly established to encourage use of public transportation, so it does not seem likely that this factor would result in a lessening of commuter bus patronage. At the least, bus commuting habits would remain unchaged from the present and this factor would be unity. The highest value for this factor is hard to gauge. With a concerted public

policy effort to encourage use of public transportation, along with a reccurance of gasoline shortages and rapidly rising prices, use of public transportation might increase 50 percent over what it otherwise might be without this factor. A value of 1.5 was therefore chosen as the high potential for this factor.

This factor is then combined with the Population-Employment multiplier:

| | Composite Growth Multiplier 1975-1990 | | |
|---|---|---|---|
| | Low Potential | High Potential | Likely |
| Population-Employment Multiplier | 1.05 | 1.50 | 1.15 |
| Commuting Habits Multiplier | 1.00 | 1.50 | 1.20 |
| Composite Growth Multiplier (Product of the above) | 1.05 | 2.25 | 1.38 |

Intercity Bus Projections

The analyses of intercity bus patronage for 1990 are done separately for Northeast Corridor traffic and non-corridor traffic. In the Northeast Corridor (cities along the Eastern seaboard between Boston and Washington), some diversion of passenger traffic from bus to rail is expected due to planned upgrading of corridor rail service by 1990. For non-corridor intercity bus traffic, diversion to rail is not considered a factor in projecting 1990 patronage. Projections of 1990 patronage for both corridor and non-corridor traffic are based on the demand analysis for intercity rail service done for the Federal Railroad Administration and documented in Northeast Corridor High Speed Rail Passenger Service Improvement Project. Task 1, Demand Analysis, April, 1975; and on the adjustments to that analysis discussed in PBQD Technical Memorandum Interim Intercity Rail Patronage, January 5, 1976.

Northeast Corridor Bus Ridership Projections. Estimates of 1990 ridership along the Northeast Corridor are based on an analysis presented in the FRA Task 1 Report and reapplied using revised base data in PBQD Technical Memorandum 11. The revised estimates are computed using an intercity travel growth multiplier of 1.40 based on the latest available 1990 population and person income forecasts for the Boston region and a modal split factor based on 4-hour Corridor rail travel time from Boston to New York. The following table summarizes the derivation of 1990 bus ridership between Boston and other Northeast Corridor cities.

| Between Boston And... | 1973 Person Trips (000's) | Most Likely 1990/1973 Growth Multiplier | 1990 Person Trips (000's) | Bus Mode Share (%) | 1990 Bus Person Trips (000's) |
|---|---|---|---|---|---|
| Providence | 9,053 | 1.40 | 12,674 | 2.5 | 319 |
| New London | 668 | 1.40 | 935 | 2.8 | 26 |
| New Haven | 725 | 1.40 | 1,015 | 11.9 | 121 |
| Bridgeport | 476 | 1.40 | 666 | 4.4 | 29 |
| New York | 5,852 | 1.40 | 8,193 | 4.7 | 385 |
| Trenton | 94 | 1.40 | 132 | .8 | 1 |
| Philadelphia | 1,064 | 1.40 | 1,490 | .8 | 12 |
| Wilmington | 119 | 1.40 | 167 | 1.0 | 2 |
| Baltimore | 289 | 1.40 | 405 | 1.6 | 6 |
| Washington | 1,144 | 1.40 | 1,601 | 1.6 | 26 |
| TOTAL | 19,484 | 1.40 | 27,278 | | 927 |

Application of low and high 1990/1973 growth multiplier -- 1.35 and 1.77 respectively — yields a range of 894,000-1,172,000 bus trips between Boston and other corridor cities in 1990.

Non-Corridor Projections. The 1973 intercity bus passenger traffic between Boston and non-corridor locations was estimated earlier in this analysis at 1,749,000 movements. No diversion from bus to rail is expected on traffic between Boston and non-corridor cities, since no sub-stantial upgrading of rail service is anticipated by 1990. The growth multipliers obtained previously are applied to 1973 patronage to yield estimates of 1990 intercity bus patronage between Boston and non-corridor cities:

| | Non-Corridor Bus Person Trips | | |
|---|---|---|---|
| | Low Potential | High Potential | Likely |
| 1973 Patronage | 1,749,000 | 1,749,000 | 1,749,000 |
| Growth Multiplier | 1.35 | 1.77 | 1.40 |
| 1990 Patronage | 2,361,000 | 3,096,000 | 2,449,000 |

Combined Projections. The forecasts of corridor and non-corridor bus patronage are combined to get a projection of total 1990 intercity bus patronage to and from Boston.

## 1990 Intercity Bus Patronage

| | Low Potential | High Potential | Likely |
|---|---|---|---|
| Northeast Corridor | 894,000 | 1,172,000 | 927,000 |
| Non-Corridor | 2,361,000 | 3,096,000 | 2,449,000 |
| Total | 3,255,000 | 4,268,000 | 3,376,000 |

### Design Day Volumes

Commuter Buses. MBTA Ridership Data for the South Shore extension of the Red Line were used to obtain seasonal patterns of commuter patronage. This transit extension principally serves commuters to downtown Boston, and it is assumed that variation in daily ridership throughout the year would closely parallel that on commuter bus lines. Average daily ridership during February, the month when ridership is highest, is used to establish design-day volumes for commuter bus lines serving South Station. Patronage forecasts for privately-owned commuter bus lines are based on cordon count data obtained on a Monday, Tuesday and Wednesday in late June. For the South Shore transit extension the average daily ridership for February is approximately 13 percent higher than during the late June period during which the cordon counts were made. Because MBTA ridership data were obtained in February, the design-day factor is unity.

To get 1990 design-day volumes, the daily ridership estimates on private commuter and mixed lines (from Table 3) are multiplied by the growth multipliers and design day factor and further adjusted to reflect an anticipated shift in downtown employment to the vicinity of South Station.

Commuter Bus Patronage Forecasts

| | MBTA | | | Other | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Low | High | Likely | Low | High | Likely | Low | High | Lik |
| 1975 1-day Ridership | 8,908 | 8,908 | 8,908 | 12,126 | 12,126 | 12,126 | 21,034 | 21,034 | 21, |
| Growth Multiplier | 1.05 | 2.25 | 1.38 | 1.05 | 2.25 | 1.38 | -- | -- | -- |
| Design Day Factor | 1.00 | 1.00 | 1.00 | 1.13 | 1.13 | 1.13 | -- | -- | -- |
| Unadjusted 1990 Design Day | 9,400 | 20,000 | 12,300 | 14,400 | 30,800 | 18,900 | 23,800 | 50,800 | 31, |
| Employment Shift Adjustment | | | | | | | 0 | 6,000 | 3,8 |
| 1990 Design Day | | | | | | | 23,800 | 56,800 | 3 |

Intercity Buses. Intercity bus patronage is assumed to show seasonal variation similar to that of intercity rail at Boston. PBQD Technical Memorandum #1 recommended that design day patronage for intercity rail be established at 0.5 percent of annual patronage. This factor is also applied to the 1990 intercity bus patronage estimates obtained previously.

1990 Design-Day One Way Intercity Bus Patronag

| | Low Potential | High Potential | Likely |
|---|---|---|---|
| 1990 Annual Patronage | 3,255,000 | 4,268,000 | 3,376,000 |
| Design-Day Factor | 0.005 | 0.005 | 0.005 |
| 1990 Design Day | 16,300 | 21,300 | 16,900 |

Time Distribution

Table 4 shows the hourly variation in ridership on privately-owned commuter, mixed, and intercity bus lines, as based on cordon count data. The distribution is similar for commuter and mixed buses, with about 30 percent of daily arrivals during the morning peak hour and 33 percent of dail departures during the afternoon peak hour. For intercity bus ridership, both the arrival and departure peaks occur between 4 and 5 p.m., with an estimated 12 percent of arrivals and 14 percent of departures during that hour.

The cordon counts, which show movements for each half hour, indicate that commuter arrivals and departures during the two adjacent peak hours are concentrated in the adjacent half-hour segments. For Transportation Center design, it is recommended that 35 percent of daily commuter arrivals or departures be assumed to occur during the peak hour, 20 percent during the peak half hour, and 12 percent during the peak 15 minutes. Patronage in the off-peak direction during the peak hour is arbitrarily set at 5 percent of daily volumes, 3 percent during the peak half-hour, and 2 percent during the peak 15 minutes.

It is recommended that peak hour intercity arrivals and departures be established as 15 percent of daily volumes, and that both peak arrival and departure periods be assumed to occur at the same time as peak commuter departures. During the peak hour for commuter arrivals, intercity arrivals and departures are set at 10 percent of daily volumes. As was assumed for intercity rail patronage, peak half-hour volumes are set at 65 percent of peak hour, and peak 15-minute volumes at 35 percent of peak hour.

These peak period percentages are applied to design day commuter and intercity patronage forecasts, and the peak-period design volumes are presented in Table 5.

Submode of Travel

The mode of travel that intercity and commuter bus passengers will use between the Transportation Center and their point of origin or destination in Boston has important implications in Transportation Center design.

A survey conducted by PBQD in November, 1975* provided data on the submode of travel used by commuter bus passengers arriving on Essex Street at the various terminals. The survey results for Essex Street in the vicinity of South Station, are shown below, along with suggested modal split percentages to be used in design of the Transportation Center. Percentages using local bus or

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*Parsons, Brinckerhoff, Quade & Douglas, Inc., Report of South Station Commuter Survey, conducted for the Boston Redevelopment Authority, January 19, 1976.

TABLE 4

COMMUTER/INTERCITY BUS RIDERSHIP TIME DISTRIBUTION (PERCENT)

| Hour Beginning | ARRIVALS Commuter | Mixed | Intercity | DEPARTURES Commuter | Mixed | Intercity |
|---|---|---|---|---|---|---|
| 6 A.M. | 5 | 2 | | 2 | 1 | 3 |
| 7 | 29 | 30 | 3 | 3 | 1 | 4 |
| 8 | 25 | 27 | 10 | 3 | 3 | 8 |
| 9 | 4 | 8 | 8 | 5 | 6 | 5 |
| 10 | 4 | 5 | 6 | 2 | 2 | 6 |
| 11 | 2 | 3 | 5 | 4 | 7 | 5 |
| Noon | 2 | 3 | 7 | 1 | 2 | 7 |
| 1 | 4 | 2 | 5 | 4 | 2 | 5 |
| 2 | 3 | 4 | 4 | 2 | 4 | 5 |
| 3 | 4 | 2 | 5 | 6 | 5 | 8 |
| 4 | 4 | 1 | 11 | 13 | 15 | 9 |
| 5 | 6 | 2 | 12 | 33 | 32 | 13 |
| 6 | 3 | 5 | 5 | 8 | 12 | 7 |
| 7 | 2 | 3 | 9 | 4 | 3 | 8 |
| 8 | 2 | 1 | 4 | 4 | 1 | 4 |
| 9 | | 1 | 5 | 3 | 1 | 1 |
| 10 | | | 1 | 1 | | 2 |
| 11 | 1 | 1 | | 2 | 3 | |
| Total | 100% | 100% | 100% | 100% | 100% | 100% |

TABLE 5

1990 DESIGN PASSENGER VOLUMES

| Peak Period | Commuter Arr. | Commuter Dep. | Intercity Arr. | Intercity Dep. |
|---|---|---|---|---|
| Design Day | 17,500 | 17,500 | 8,500 | 8,500 |
| 8-9 A.M., 60 minutes | 6,125 | 875 | 850 | 850 |
| 30 minutes | 3,500 | 525 | 550 | 550 |
| 15 minutes | 2,100 | 350 | 300 | 300 |
| 5-6 P.M., 60 minutes | 875 | 6,125 | 1,280 | 1,280 |
| 30 minutes | 525 | 3,500 | 810 | 810 |
| 15 minutes | 350 | 2,100 | 450 | 450 |

subway are adjusted upward from the survey results to account for increased use during bad weather and possible changes due to moving bus lines from other terminals to South Station.

For intercity bus, the submode split is assumed to be similar to that for intercity rail, with the exception that fewer bus travelers would use the park-and-ride mode and more would use the subway. The suggested submode design percentages for commuter and intercity bus are shown in Table 6

TABLE 6

1990 SUBMODE SPLIT

| Submode | Commuter Bus Fair | Commuter Bus Inclement | Intercity Bus All Weather |
|---|---|---|---|
| Walk | 80% | 72% | 10% |
| Subway | 12 | 15 | 40 |
| Local Bus | 6 | 10 | 5 |
| Taxi | 0 | 1 | 10 |
| Kiss & Ride | 0 | 0 | 20 |
| Park & Ride | 0 | 0 | 3 |
| Intra-terminal | 2 | 2 | 12 |
| | 100% | 100% | 100% |

Bus Volumes

Table 7 shows estimated daily and peak period design-day bus movements for 1990.

Commuter bus daily totals are obtained by multiplying 1975 scheduled buses by 1.66, which represents the change in ridership from current estimated levels to 1990 design-day levels.

Peak-period commuter bus movements are based on passenger volumes in Table 5 and calculated by assuming an average peak-period ridership of 35 passengers per bus in the peak flow direction, and 20 passengers per bus in the off-peak flow direction.

For intercity buses, movements were calculated from design-day ridership in Table 5, on the basis of 30 passengers per bus during all periods of the day.

TABLE 7

1990 DESIGN-DAY BUS ARRIVALS AND DEPARTURES

| | Commuter * | | Intercity ** | |
|---|---|---|---|---|
| | Arrivals | Departures | Arrivals | Departures |
| Design Day | 661 | 661 | 257 | 257 |
| A.M. Peak Hour | 175 | 44 | 26 | 26 |
| A.M. Peak 1/2 Hour | 100 | 26 | 16 | 16 |
| A.M. Peak 15 Minutes | 60 | 18 | 9 | 9 |
| P.M. Peak Hour | 44 | 175 | 39 | 39 |
| P.M. Peak 1/2 Hour | 26 | 100 | 26 | 26 |
| P.M. Peak 15 Minutes | 18 | 60 | 14 | 14 |

* Design Day Buses from current weekday totals multiplied by ridership growth factor of 1.66. Peak Period Buses from Passenger Volumes @ 35 pax/bus. Off-Peak Buses from Passenger Volumes @ 20 pax/Bus

** All Intercity Bus movements figured from passenger volumes @ 30 pax/Bus.

Technical Memorandum #3

FUTURE COMMUTER RAIL PATRONAGE

Five commuter rail lines, operated by the Penn Central for the MBTA, provide service between South Station and the suburbs to the south and west of Boston. These lines are the Providence Main Line, Needham Branch, Franklin Branch, Stoughton Branch, and Framingham Line (along B & A tracks). All trains on each of these lines stop at Back Bay Station as well as the South Station terminal.

1980 Projection

Average daily weekday ridership on each of the lines for 1974, and projections of daily ridership for 1980, were obtained from the Central Transportation Planning Staff.*
These are shown in Table 1.

TABLE 1

COMMUTER RIDERSHIP

| Branch | Average Weekday Ridership (Inbound) 1974 | 1980 CTPS Projection |
|---|---|---|
| Providence Main Line | 1881 | 2200 |
| Needham | 1457 | 1900 |
| Franklin | 1063 | 1500 |
| Stoughton | 576 | 700 |
| Framingham | 631 | 750 |
| | 5608 | 7050 |

* CTPS projections provided by C. Kalauskas in telephone conversation December 11, 1975.

The 1980 projections are based on population increases for 1980 and a slight upgrading in service and facilities expected by that year.

These ridership figures include passengers using both South Station and Back Bay. A breakdown of ridership at each station is not available, but CTPS assumes that one-third of the riders use Back Bay and two-thirds use South Station. A recent survey by CTPS of riders on the Framingham branch showed that about 70 percent use South Station. Gray Lines, however, offers commuter bus service from Framingham to Park Square that competes with that rail line and that is more convenient for some people who would otherwise use the Back Bay Station. The one-third/two-third split is probably still close to that for all Penn Central commuters. Commuter rail ridership at South Station, for 1980, then, would be two-thirds of 7050 or 4700 in each direction.

1990 Projection

The CTPS 1980 ridership projections are accepted as valid for that year, and these figures are then adjusted to account for changes expected between 1980 and 1990.

Recent population projections for 1980 and 1990 are compared for the towns in the BTPR region served by the five commuter rail lines. On the high side of aggregate population increases projected for these towns is the 24 percent increase forecast by the BTPR in 1972. A more recent estimate, done for the MDC by Metcalf and Eddy, forecasts a 10 percent minimum increase in population for these towns between 1980 and 1990.

Another factor that should be considered in preparing ridership forecasts is the effect of policy decisions. Reductions in service, or even abandonment of service or conversion of one or more lines to a rapid transit extension, would reduce commuter rail ridership. Significant fare increases would also reduce ridership. On the other hand, fare reductions, increases in service, or an increase in the expense or inconvenience of competing modes of transportation would have the effect of increasing commuter rail ridership. Possible effects of such policy decisions are estimated here to range from a reduction of ridership by 30 percent to a growth of 30 percent in the 1980-1990 period.

Estimated population and policy factors and a composite multiplier are presented below.

| | Population and Policy Multiplier (1980-1990) | | |
|---|---|---|---|
| | Low Potential | High Potential | Likely |
| Population Factor | 1.10 | 1.24 | 1.15 |
| Policy Factor | 0.70 | 1.30 | 1.00 |
| Composite Multiplier (product of above factors) | 0.77 | 1.61 | 1.15 |

Back Bay Station

The above multipliers apply to all commuters on rail lines, using both South Station and Back Bay. The current split of patronage is approximately one-third at Back Bay and two-thirds at South Station. This could change by 1990. Currently under consideration are plans to relocate the Orange Line transit line to the railroad right-of-way in the Southwest Corridor. This project would include construction of a new Orange Line stop at Back Bay. As part of the construction process, Back Bay may be closed for several years. By 1990, however, Back Bay Station should be back in full operation.

A temporary closing of Back Bay will have the effect of reducing the number of riders there when the station reopens. At the same time, completion of the Transportation Center at South Station, will increase the attractiveness of South Station as a destination. On the other hand, provision of a new Orange Line transit stop at Back Bay will make it more convenient for other passengers to use that station and ride the subway to destinations downtown or elsewhere in Boston. Because of the uncertainty of these future plans, and because they have a tendency to cancel out the effects of one another, the 1990 passenger split will be assumed to remain in one-third Back Bay, two-thirds South Station.

Employment Shifts

Shifting employment patterns in the downtown area could also affect commuter rail ridership. As explained in Technical Memorandum #2, prepared as part of the patronage forecast effort for the South Station Transportation Center, employment in the immediate vicinity of South Station is expected to increase by 19,000 by 1990. The locational convenience can be expected to induce additional riders to commuter buses and trains serving South Station, over and above the general ridership increases due to population and policy changes. Previous studies have not considered the effects of shifting employment patterns within the CBD on commuting modes. For this analysis, 10 percent of this new employment in the immediate vicinity of South Station is forecast to use commuter buses, because of the added convenience. Penn Central commuter trains, which serve a more limited area and carry about half as many riders as commuter buses, are likely to capture five percent of these workers, or about 1000 additional daily riders. This sum can be added directly to the 1990 design day commuter rail projections for South Station.

Design Day Volumes

The ridership volumes discussed above are weekday ridership averaged throughout the year. Commuter ridership tends to be slightly higher than average during the winter months, and it diminishes somewhat in summer when people are on vacation and schools are not in session. MBTA data for the South Shore Red Line extension shows that average daily ridership during February, the peak month, is approximately 12 percent above the daily ridership averaged throughout the year. The South Shore transit extension carries mostly commuters to downtown Boston, and it is assumed that ridership patterns are similar to those for commuter rail. It is recommended that average weekday ridership for February be used as design-day volumes for Transportation Center commuters, and that the design-day factor of 1.12 be used.

To obtain design-day volumes for commuters to the South Station Transportation Center, the 1980 estimated ridership is multiplied by the 1980-1990 growth multipliers, and by the design-day factor of 1.12. The ridership increase expected because of employment pattern shifts is added to the product.

| | Design-Day One-Way Commuter Rail Patronage | | |
|---|---|---|---|
| | Low Potential | High Potential | Likely |
| 1980 South Station Forecast | 4700 | 4700 | 4700 |
| Growth Multiplier 1980-1990 | 0.77 | 1.61 | 1.15 |
| Design-Day Factor | 1.12 | 1.12 | 1.12 |
| 1990 Patronage Subtotal | 4100 | 8500 | 6000 |
| Employment Shift Addend | 0 | 1500 | 1000 |
| 1990 South Station Patronage | 4100 | 10,000 | 7000 |

Hourly Distribution

Data obtained from the MBTA for commuter trains during the peak periods on September 29, 1975 indicates that commuter rail ridership exhibits extremely sharp peaks. Inbound, about 73 percent of daily riders were on trains scheduled to arrive during the peak hour (between 7:55 and 8:54). About 59 percent

were on trains scheduled to arrive during one half-hour period, and 44 percent during a single 15-minute period. In the afternoon, about 66 percent of daily riders were on trains departing during the peak hour (4:45-5:54), 52 percent during a half-hour period, and 45 percent during a 15-minute period.

With future patronage increases, much of the additional ridership can be expected to occur outside of the peak periods, when trains and facilities are less crowded. It is suggested that design volumes be established at 60 percent of daily patronage during the peak hour, 50 percent during the peak half-hour and 40 percent during the peak 15 minutes, for both arriving and departing passengers . Patronage in the off-peak direction is very light, and is arbitrarily set at one percent of the daily volume during each period.

These peak-period design percentages are applied to the likely 1990 design-day patronage obtained previously. The peak period design volumes are presented in Table 2.

TABLE 2

1990 COMMUTER TRAIN DESIGN VOLUMES

| | Arrivals | | Departures | |
|---|---|---|---|---|
| | Percentage | Number | Percent | Number |
| Daily | 100 | 7000 | 100 | 7000 |
| Morning Peak Hour (8-9) | 60 | 4200 | 1 | 70 |
| Morning Peak 1/2 Hour (8-8:30) | 50 | 3500 | 1 | 70 |
| Morning Peak 15 Min. (8-8:15) | 40 | 2800 | 1 | 70 |
| Afternoon Peak Hour (4:45-5:45) | 1 | 70 | 60 | 4200 |
| Afternoon Peak 1/2 Hour (5-5:30) | 1 | 70 | 50 | 3500 |
| Afternoon Peak 15 Min. (5-5:15) | 1 | 70 | 40 | 2800 |

Submode of Travel

The modes that rail commuters use to travel between South Station and their destinations in downtown Boston were investigated in a survey of commuters conducted by PEO&D in November 1975. The survey results for commuters arriving at South Station during the morning peak hours are shown

below, along with suggested submodal split percentages to be used in design of the Transportation Center. The percentages of commuters found by the survey to be using local bus or subway were adjusted upward, to account for increased use during bad weather. The suggested design percentages for commuter rail are the same as those used for commuter bus.

| | Commuter Rail Submode of Travel | |
|---|---|---|
| | Fair Weather | Inclement Weather |
| Walk | 80% | 72% |
| Subway | 12 | 15 |
| Local Bus | 6 | 10 |
| Taxi | 1 | 1 |
| Intra-terminal | 2 | 2 |

Commuter Rail Schedule and Train Consists

The daily distributions of commuter train arrivals and departures at South Station are expected to remain much the same as at present. Since the maximum consist of commuter trains at present is only eight cars, the estimated increases in patronage by 1990 could be handled by adding additional cars to presently scheduled trains. The hourly distributions of commuter train arrivals and departures at South Station are presented on Table 3.

## TABLE 3

## COMMUTER TRAIN ARRIVALS AND DEPARTURES AT SOUTH STATION
(From July 1, 1975 Schedule)

| Hour Beginning | Arrivals | Departures |
|---|---|---|
| 5 a.m. | 0 | 1 |
| 6 | 0 | 3 |
| 7 | 5 | 3 |
| 8 | 11 | 1 |
| 9 | 4 | 3 |
| 10 | 4 | 2 |
| 11 | 1 | 0 |
| 12 Noon | 1 | 2 |
| 1 p.m. | 1 | 1 |
| 2 | 1 | 2 |
| 3 | 3 | 2 |
| 4 | 1 | 6 |
| 5 | 1 | 10 |
| 6 | 3 | 3 |
| 7 | 4 | 0 |
| 8 | 0 | 1 |
| 9 | 1 | 2 |
| 10 | 1 | 0 |

## Technical Memorandum #4

## TRANSPORTATION CENTER PARKING

The issues of how many parking spaces should be provided as part of the Transportation Center, peak hourly discharge, approach direction, trip purpose of users, deviation of parking, and the provision of new ramp connections were first presented and analyzed in Trade and Transportation Center, Analysis of South Station Development Potentials, by Robert Gladstone & Associates for Massachusetts Port Authority, December, 1965. Since that time the BRA has modified some of the previously accepted recommendations as assumptions have changed.

### Evolution of Parking Facility Proposal

Initial Gladstone Recommendation. The Gladstone Report recommended that the garage provide 5,000 spaces and pointed out that even this number would not be sufficient to meet parking demand forecast for 1985. This assertion was based on the assumptions that:

- o the forecast demand for CBD and South Cove parking would exceed the estimated future supply by 9,500 to 10,800 spaces
- o a moving pedestrian conveyance between the CBD and South Station would be provided and
- o on-site development would generate demand for parking within a range of 2,900 to 3,650 spaces.

The directional percentage split of users approaching the garage was estimated using EMRPP data. Gladstone estimated that 42 percent of the potential users would approach via the Expressway or the Turnpike.

Direct access to the Turnpike and Expressway (northbound and southbound) was described as being necessary. With ramps providing this access, it was estimated that the adjacent surface streets would operate at 90 percent of capacity, and the ramps would operate at about 50 percent of capacity. No mention was made of the volume-to-capacity ratio on the Expressway or Turnpike. Design volume was assumed to be 80 percent of garage capacity during the peak hour.

A 7,000-car gagage would cause the ramps to operate at capacity. However, for a garage of this size, capacity restraint on adjacent local streets would cause what was felt to be a disproportinately high approach split from the Expressway and Turnpike.

If no ramp changes were made, it was estimated that the maximum possible garage size would be about 2,400 spaces. Such a facility would cause the adjacent streets to operate at full capacity.

In summation, the Gladstone Report recommended building as large a garage as the adjacent street system could handle. This was consistent with the prevalent assumptions of 1965:

- that highway capacity should be expanded to meet forecast demand;
- that parking capacity should be expanded to meet the increased demand resulting from increases in highway capacity;
- that adverse environmental effects such as air quality degradation should be accorded only secondary importance;
- that the energy supply was, for all practical purposes, unlimited.

Obviously, these assumptions are no longer valid. The current assumptions regarding demand will be discussed in the next section.

The BRA reduced the proposed number of spaces to 3,500. All the reasons for this are not known, but it was thought at the time that connections between the garage and the Expressway, to and from the north, was a practical impossibility.

The BRA has since reduced the proposed number of parking spaces to 2,500, the current number. The reasons for this are not known. Possible contributing factors are the virtual removal from consideration of a moving pedestrian conveyance and discouraging results of a ramp feasibility study.

Modifications to Initial Recommendations. In order to conform to current State transportation policies and EPA clean air policies it is expected that each new parking space at South Station will be coupled with the elimination of an existing parking space elsewhere in downtown. The proposed facility would offer several advantages over existing facilities.

- o fringe parking will reduce VMT on city streets;
- o CBD lots will be made available for higher economic uses;
- o intercity rail and bus will be better served; and
- o a proposed new arena would be better served.

Mostspaces in the proposed facility would duplicate the functions of the existing facilities.

It appears that only a major improvement in the public transportation system would decrease parking demand in this part of the CBD, where most major facilities are currently filled to capacity.[1]

User Characteristics: Non-Transportation Center

Trip Purpose. Consideration has been given to serving shoppers, and other short-term parkers rather than all-day commuters. This could be accomplished by holding a previously determined percentage of spaces open until 9:30 a.m., or by instituting a rate system favorable to short-term users. This type of rate system could be a constant per-hour rate, or a surcharge added to the daily rate for vehicles leaving during the evening peak hour.

Realistically, it is questionable whether controls to favor short term parking could be implemented. Public parking facilities are under the jursidiction of the Boston Real Property Board, which leases them out to private operators for time periods up to 40 years. [2]

It appears that parking facility operators have relative freedom in the establishment of rate structures. In most cases, rate structures have been set to favor all-day parkers.[3]

In the absence of specifically stated intentions to devote some or all of the proposed Transportation Center Garage to non-commuter parking, it is reasonable to assume that the split among trip purposes would be similar to that of existing facilities in the CBD. A weighted average of trip purpose splits for 4 garages in the vicinity of South Station is presented in Table 1.

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1. Wilbur Smith and Associates, Final Report An Access Oriented Parking Strategy for the Boston Metropolitan Area for Massachusetts Department of Public Works, Boston, July, 1974, Figure 43.

2. Op cit, Wilbur Smith and Associates, p 194

3. Op cit, Wilbur Smith and Associates, p 195

TABLE 1

TRIP PURPOSES FOR PARKERS IN DOWNTOWN BOSTON

| | |
|---|---|
| Work | 64.9% |
| Personal Business | 7.1 |
| Sales Visit | 2.7 |
| Service | 1.0 |
| Recreational | 0.5 |
| Shopping | 22.7 |
| Other | 1.1 |
| TOTAL | 100.0% |

Parking Duration. Average parking duration by trip purpose has been estimated for the financial and retail districts in downtown Boston.[4] The range in average work trip parking durations is from 5.5 hours for managers in the retail district to 7.2 hours of employees in the financial district. Average parking durations for all other trip purposes were short term, ranging from 1.7 hours for retail district service trips to 2.8 hours for retail district miscellaneous trips.

Peak Entry and Discharge Rates. As stated above, the Gladstone Report assumed a critical discharge rate of 80 percent of garage capacity in a peak hour. A Boston Redevelopment Authority interoffice memorandum from E. Colby to A. Howard, dated September 17, 1974, recommends continued use of the 80 percent figure, stating that it might be somewhat high, but it provides a margin of safety. This memo cites 1972 studies by Wilbur Smith and Associates of discharge rates at Boston parking facilities. The Post Office Square and Government Center Garages appear to have peak hourly discharge rates of 79 and 76 percent respectively and peak half-hourly discharge rates of 56 and 49 percent respectively.

To determine the critical peak hour entry volume, the total inbound traffic volume crossing the 1974 Boston Proper Cordon Line for the morning peak hour was compared to the volume leaving during the evening peak hour. Inbound morning volume was found to be 90 percent of outbound evening volume. From this it was estimated that 90 percent of 80 percent, or 72 percent of the capacity of the non-Transportation Center portion of the facility would enter during the morning peak hour.

4. Op cit, Wilbur Smith and Associates, Table 58 and Figure 44

Also from 1974 Cordon Count data, morning peak 1/2-hour and evening peak 1/2-hour volumes were compared to their corresponding peak hour volumes. As a result of this it is estimated that 36 percent of the capacity of the garage (non-Transportation Center) will enter during the morning peak 1/2-hour and 41 percent will leave during the evening peak 1/2-hour.

Peak and Average Use. A well designed, well located garage in an area of substantial parking demand should reach approximately full occupancy between 12:00 and 1:30 P.M. If conditions regulating downtown parking remain substantially as they are, the relationship between peak use and average use should reflect that of some better patronized existing garages. The relationship for some of these was stated as ranging from .79 to .90. [5] Therefore, it is estimated that average use will be approximately 83 percent of capacity between 10:00 A.M. and 6:00 P.M.

User Characteristics: Transportation Center

Intercity Rail. The Federal Railroad Administration has recommended that 865 parking spaces in the proposed facility be reserved for intercity rail park-and-ride passengers. This is approximately equal to the number of park-and-riders on the design day, i.e. 8% of design-day originations.

A review of the intercity rail ridership forecast[6] prepared as part of the programming effort for the South Station Transportation Center suggests that the station be designed to accommodate 6,425 originating passengers per day and that 8% of those passengers would use the park-and-ride mode, at 1.5 passengers per car.

If the FRA's assumed 1-day average duration for long term parking is accepted, then the revised requirement for intercity rail parking would be approximately 345 spaces.

Short-term parking and auto curb space requirements should be based on peak 15-minute arrivals and departures of kiss-and-riders on the design day. The FRA patronage and design analyses produced the short-term parking and automobile drop-off and pick-up space requirements shown in Table 2 for the South Station rail terminal. The FRA design-day and peak period patronage projections for intercity rail were subsequently revised by Parsons, Brinckerhoff, Quade & Douglas on the basis of more recent population projections and higher rail travel times. The modal split percentages for kiss-and-ride passengers were also revised, based on observations of

5. Op cit, Wilbur Smith and Associates, Table 63

6. Parsons, Brinckerhoff, Quade & Douglas, Inc., Technical Memorandum, Future Intercity Rail Patronage, January 5, 1976, p.9.

of conditions in Boston.

Because the methodology used in the FRA analysis to determine kiss-and-ride space requirements is not presented in its publications, and because the reason for the great difference between the number of pick-up and drop-off spaces is not apparent, the curb-space and short-term parking requirements are calculated in Table 2 based on the revised projections for 15-minute peak period kiss-and-ride travelers.

The following assumptions are used in calculating these kiss-and-ride space requirements:

1. each kiss-and-ride automobile carries an average of 1.5 intercity rail travelers;

2. half of the automobiles meeting arriving kiss-and-ride passengers will use short-term parking and half will use curbside pick-up;

3. one-third of the automobiles bringing departing kiss-and-ride passengers will use short-term parking and two-thirds will use curbside drop-off;

4. average short-term parking time of 30 minutes;

5. average auto unloading time of 2 minutes; and

6. average auto loading time of 3 minutes.

TABLE 2

INTERCITY RAIL KISS-AND-RIDE SPACE REQUIREMENTS

| | FRA Estimate | PBQ&D Analysis |
|---|---|---|
| Short-Term Parking Spaces | 50 | 144 |
| Automobile Drop-Off Spaces | 20 | 8 |
| Automobile Pick-Up Spaces | 2 | 9 |

Critical hour entry and discharge rates must be calculated for intercity rail park-and-ride spaces. In Technical Memorandum #1 it was estimated that 11 percent of design day intercity rail arrivals would occur between 5:00 and 6:00 P.M. and that 11 percent of design day departures would occur between 8:00 and 9:00 A.M.[7] In the absence of more information on parking duration, it is assumed that 11 percent of high speed rail garage long-term capacity would be expected during the design morning peak hour and 11 percent of capacity would be expected to leave during the design evening peak hour. Short-term parking should be designed for 100% turnover in a 30-minute period.

Intercity Bus. Bus passengers will have lower long-term parking usage than rail passengers. Assuming one-day parking duration for 3% of a design day's 8,500 departing passengers, at 1.5 passengers per car, results in an estimated 170 long-term parking spaces for intercity bus passengers. Fifteen percent of these spaces will turn over during a peak hour.

Following the procedure described above for intercity rail short-term parking it is estimated that the intercity bus facility will need 100 short-term parking spaces, 6 pick-up spaces, and 5 drop-off spaces. Short-term parking should be designed for 100% turnover in a 30-minute period.

Summary of Transportation Center Parking and Traffic Generation

A summary of the parking space needs for each of the Transportation Center facilities is presented in Table 3. Rail and bus traveller needs are based on information developed in this memorandum. Commuter parking is estimated as the balance of the 2,500 spaces assumed for the entire parking facility.

TABLE 3

SUMMARY OF PARKING SPACE NEEDS

| | Rail | Bus | Commuter | Total |
|---|---|---|---|---|
| Long-term | 345 | 170 | 1,741 | 2,256 |
| Short-term | 144 | 100 | | 244 |
| | 489 | 270 | 1,741 | 2,500 |

7. Op cit, Parsons, Brinckerhoff, Quade & Douglas, Inc., p.9.

Private auto traffic generated by the rail, bus, and commuter short-term and long-term parking facilities is summarized in Table 4 for the morning and evening peak hours. Each 1.5 park-and-ride passengers departing by train or bus generate one arriving auto, and each 1.5 park-and-ride passengers arriving by train or bus generate one departing auto. Each 1.5 kiss-and-ride passengers generate one auto arrival and one auto departure when they depart the terminal and when they arrive.

TABLE 4

SUMMARY OF PEAK PERIOD PRIVATE AUTO TRAFFIC

| | Rail | | Bus | | Commuter | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Arr. | Dep. | Arr. | Dep. | Arr. | Dep. | Arr. | Dep. |
| 8-9 A.M. | | | | | | | | |
| Long-term Parking | 37 | 37 | 17 | 17 | 1,254 | 50 | 1,308 | 104 |
| Other | 280 | 280 | 340 | 340 | | | 620 | 620 |
| 5-6 P.M. | | | | | | | | |
| Long-term Parking | 53 | 37 | 26 | 26 | 200 | 1,393 | 279 | 1,456 |
| Other | 340 | 340 | 510 | 510 | | | 850 | 850 |

Approach Routes

Approach routes to the Transportation Center garage have been analyzed with reference to the 1974 downtown Boston Cordon Count. In distributing parkers to various access routes, it is assumed that they will approach via the Southeast Expressway, the Central Artery, the Massachusetts Turnpike, and local streets in numbers approximately proportional to the numbers on these access routes to the CBD. The following table gives the estimated access routes with and without direct access to the garage from the Central Artery.

TABLE 5

ACCESS ROUTES TO SOUTH STATION AREA

| Access Route | % of Motorists |
|---|---|
| Kneeland Street | 11 |
| Massachusetts Turnpike | 11 |
| Local Streets from North | 15 |
| Expressway from North | 20 |
| Summer Street, Congress Street and Northern Avenue Bridges | 5 |
| Local Streets from South | 12 |
| Expressway from South | 26 |
| | 100 |